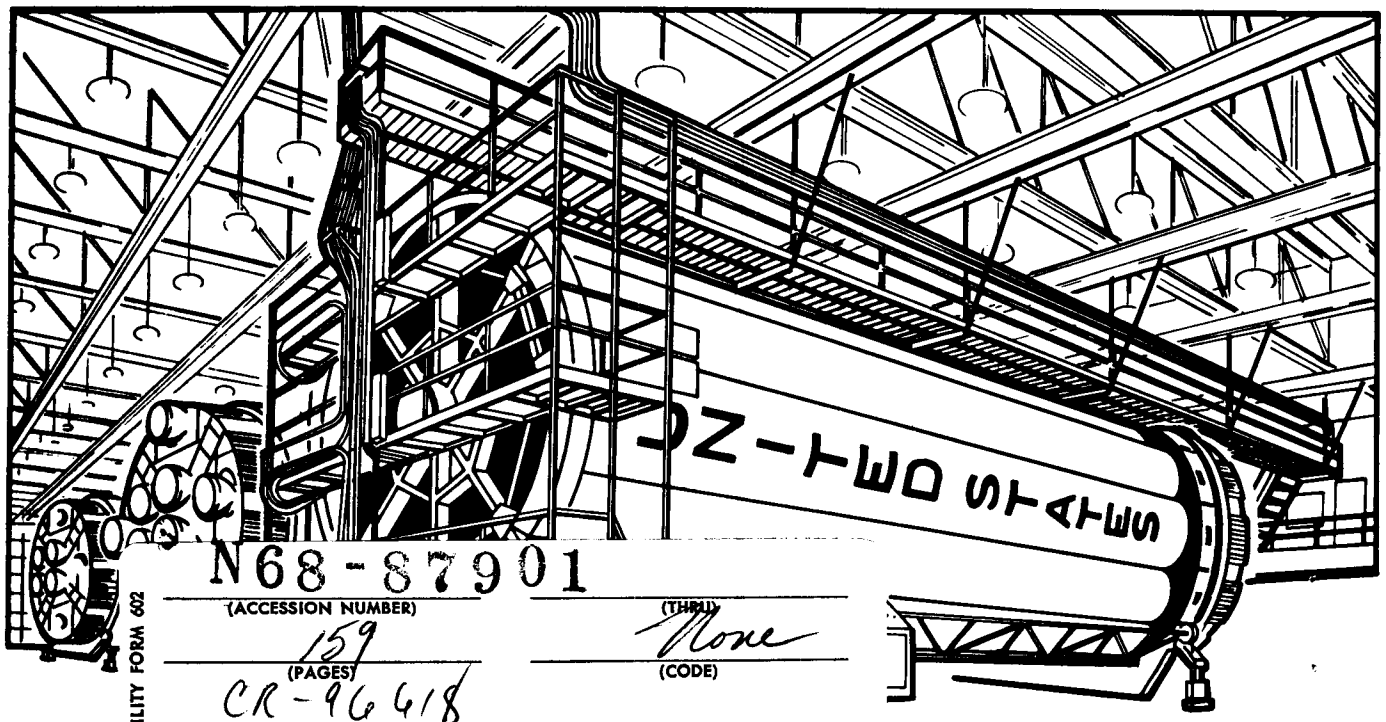
RB-B5-EIR-5.1

# UPRATED SATURN I

## S-IB STAGE

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## SUPPLEMENT

## ASSEMBLY AND TEST REPORT

SEP 1968
RECEIVED
NASA STI FACILITY
INPUT BRANCH

## S-IB-5

RB-B5-EIR-5.1
Supplement 1

# UPRATED SATURN I

## S-IB STAGE

## SUPPLEMENT
## ASSEMBLY AND TEST REPORT
## S-IB-5

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SPACE DIVISION CHRYSLER CORPORATION

New Orleans, Louisiana 25 March 1968

## ABSTRACT

The purpose of this publication is to supplement the S-IB-5 Assembly and Test Report, RB-B5-EIR-5.1, dated 10 August 1966. It is intended to summarize significant events and problems encountered on Uprated Saturn I Stage S-IB-5 from time of movement to in-house storage until shipment to Kennedy Space Center, Florida. A notation referring to this supplement should be inserted on the title page of the basic publication.

The total number of pages in this publication is 162

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# GLOSSARY OF ABBREVIATIONS

| Abbreviation | Definition |
|---|---|
| AC | Alternating current |
| AIECR | Acceptance Inspection Equipment Control Record |
| Amp | Ampere(s) |
| C | Centigrade |
| cal | calibrate |
| CCSD | Chrysler Corporation Space Division |
| CDR | Command Destruct Receiver |
| CG | Center of gravity |
| cps | cycles per second |
| db | decibel(s) |
| DC | Direct current |
| DDAS | Digital Data Acquisition System |
| DEE | Digital Event Evaluator |
| DMN | Defective Material Notice |
| EBW | Exploding Bridge Wire |
| ECP | Engineering Change Proposal |
| EMF | Electromotive force |
| EO | Engineering Order |
| ESE | Electrical Support Equipment |
| F | Fahrenheit |
| FABU | Fuel Additive Blender Unit (H-1 Engine) |
| FFADS | Functional Failure Analysis Data Sheet |
| FM | Frequency Modulation |
| g | gravity(s)-acceleration |
| GFE | Government furnished equipment |

## GLOSSARY OF ABBREVIATIONS (continued)

| Abbreviation | Definition |
|---|---|
| GFP | Government furnished property |
| GG | Gas Generator (H-1 Engine) |
| $GH_2$ | Gaseous hydrogen |
| $GN_2$ | Gaseous nitrogen |
| GOX | Gaseous oxygen |
| GSE | Ground Support Equipment |
| HF | High frequency |
| hz | hertz |
| IFV | Igniter Fuel Valve (H-1 Engine) |
| IMV | Ignition Monitor Valve (H-1 Engine) |
| K | thousand |
| khz | kilohertz |
| KSC | Kennedy Space Center |
| $LH_2$ | Liquid hydrogen |
| LOX | Liquid oxygen |
| LTV | Ling Temko Vought |
| M | Million |
| ma | milliamperes |
| MAF | Michoud Assembly Facility |
| MEP | Manufacturing Engineering Procedure |
| MF | Marshall Fitting |
| MFV | Main Fuel Valve (H-1 Engine) |
| mhz | meghertz |
| MLV | Main Lox Valve (H-1 Engine) |
| MRB | Material Review Board |
| MSFC | Marshall Space Flight Center |
| mv | millivolts |

## GLOSSARY OF ABBREVIATIONS (continued)

| Abbreviation | Definition |
|---|---|
| NAA | North American Aviation |
| NASA | National Aeronautics and Space Administration |
| NSN | No serial number |
| ODOP | Offset dopler |
| PAM | Pulse Amplitude Modulation |
| PAN | Purge Action Notice |
| PCM | Pulse Coded Modulation |
| psi | pounds per square inch |
| psia | pounds per square inch absolute |
| psid | pounds per square inch differential |
| psig | pounds per square inch gauge |
| PVC | Polyvinyl chloride |
| PWA | Printed wiring assembly |
| QC | Quality Control |
| QCI | Quality Control Instruction |
| QD | Quick disconnect |
| RDSM | Remote Digital Sub-multiplexer |
| RF | Radio frequency |
| rms | root mean square |
| rpm | revolutions per minute |
| scfm | standard cubic foot (feet) per minute |
| scim | standard cubic inch (inches) per minute |
| SCO | Subcarrier oscillator |
| SN | Serial number |
| SPGG | Solid Propellant Gas Generator (H-1 Engine) |
| STTE | Static Test Tower East |

## GLOSSARY OF ABBREVIATIONS (continued)

| Abbreviation | Definition |
|---|---|
| TM | Telemetry |
| TOP | Thrust OK pressure (switch) |
| UCR | Unsatisfactory Condition Report |
| UMA | Universal Measuring Adapter |
| UHF | Ultrahigh frequency |
| V | Voltage |
| vac | voltage (alternating current) |
| VCO | Voltage control oscillator |
| vdc | voltage (direct current) |
| VHF | Very high frequency |
| VSWR | Voltage standing wave ratio |
| WAN | Work Authorization Notice |

# INTRODUCTION

Authorization.

This narrative supplement forms a part of the Quality Program Provisions for Space Systems Contractors as outlined by paragraph 14.2.4 of NASA Quality Publication NPC 200-2, April 1962 edition, under NASA Contract NAS 8-4016.

Coverage.

This supplement covers stage S-IB-5 during the period from movement to in-house storage through shipment to KSC and is divided into major sections covering operations, modification and refurbishment, special inspections, subsystem and end-item testing, and problems and malfunctions that were considered significant.

Preparation.

This supplement was prepared by the Inspection Services Section of the Product Inspection and Test Branch, Quality Control Department, Chrysler Corporation Space Division, New Orleans, Louisiana. All data was extracted from entries on original QC documents as recorded by QC inspection and test personnel. These original QC documents are retained in the files of the Inspection Services Section as a part of the S-IB-5 historical files.

# SECTION I

# SCOPE AND STAGE HISTORY

## 1.1 SCOPE

1.1.1 The information herein is provided to supplement the Assembly and Test Report, S-IB-5, dated 10 August 1966, and concerns the S-IB-5 stage of Uprated Saturn I Space Vehicle AS-205. The S-IB booster stage was manufactured by Chrysler Corporation Space Division, Michoud Assembly Facility, New Orleans, Louisiana, under National Aeronautics and Space Administration Contract NAS 8-4016.

1.1.2 The coverage of this supplement is from the time stage S-IB-5 was moved to in-house storage at CCSD-MAF on 10 August 1966, until shipment to Kennedy Space Center, Florida on 25 March 1968.

1.1.3 Information in this supplement pertains to in-house storage, modification and refurbishment, post storage reverification checkout, and preparation for shipment including all operations, significant modifications, special inspections, significant failures and discrepancies, and final configuration data.

## 1.2 SIGNIFICANT EVENTS

Table 1-1 is a continuation of the chronological record of significant events regarding stage S-IB-5 that is tabulated under paragraph 1.4.1 of the basic publication.

Table 1-1. Significant Events, Stage S-IB-5

| Date | Event |
|---|---|
| 10 Aug 1966 | Movement to In-House Storage at MAF |
| 31 Aug 1967 | Modification and Refurbishment Started |
| 28 Dec 1967 | Post Storage Reverification Checkout Started |
| 13 Mar 1968 | Preparation for Shipment to KSC Started |
| 25 Mar 1968 | Shipment to KSC |

## 1.3 IN-HOUSE STORAGE

Stage S-IB-5 was made available for shipment to KSC and accepted by NASA on 10 August 1966. However, it was directed by NASA to place the stage in a storage status at MAF until such time the stage is required by the government at KSC. The new need date for stage S-IB-5 at KSC was established to be 30 March 1968.

### 1.3.1 CONVERSION TO STORAGE CONFIGURATION

Stage S-IB-5 was converted from the 60C00247 road shipment preservation configuration to the storage configuration. Accordingly, heat shield panel assemblies 60C30559 and 60C30557, adjacent to fins 1 and 5 respectively, were removed and placed in bonded stores. The openings left by the removed heat shield panel assemblies were covered with PS50084 cloth which was retained by PS50291 tape. All desiccant retainers that had been installed remained in place; however, checks of humidity indicators were made weekly, throughout the storage period, to insure proper relative humidity (30 percent) in protected stage areas. Desiccant was changed as required.

## 1.3.2 MODIFICATION DURING STORAGE

During the extended period of in-house storage of stage S-IB-5, numerous major and minor modifications were incorporated into stage configuration and special inspections performed. Modifications were in compliance with CCSD Engineering Orders and were processed as directed by CCSD Modification Bulletins. In order to accomplish modification and/or inspection, seal plates, heat shield panels, and access doors were removed for access and subsequently reinstalled. Strict control was maintained on personnel and tooling ingress and egress. A comprehensive coverage of significant modifications and special inspections accomplished during the storage period is provided in Section II of this supplement.

## 1.3.3 INSPECTION DURING STORAGE

1.3.3.1 In-Process Inspection. Aside from the aforementioned weekly desiccant checks performed during the storage period, it was necessary to conduct in-process inspections while incorporating and subsequent to modification. In-process inspections were conducted to assure that quality levels were maintained, components and assemblies were in conformance with applicable drawings, specifications, and EOs, and that strict control of personnel and tooling ingress and egress to stage areas was provided. Significant failures and discrepancies found during storage are covered in Section IV of this supplement.

1.3.3.2 Special Inspections. During and subsequent to in-house storage, several special inspections were conducted. Special inspections are performed on one stage system or subsystem, due to a similar system having encountered a specific problem on another stage or to determine the extent or investigate a particular problem on the stage. In some cases a special inspection may be conducted in compliance with government direction. Significant special inspections conducted on stage S-IB-5 during the period from movement to in-house storage until shipment of the stage to KSC are covered in Section II of this supplement.

## 1.4 MODIFICATION AND REFURBISHMENT

Work Authorization Notice 165, as amended through revision P, controlled movement to storage, storage, and removal from storage with direction for subsequent modification and refurbishment. The modification and refurbishment period began on 31 August 1967 and included the following general tasks:

a. Incorporation of all outstanding ECPs

b. Clearance of current discrepancy documentation (DMNs, FFADS, squawks)

c. Completion of all GFP Rework Work Orders

d. Replacement of age-controlled and cycle-controlled items as necessary

### 1.4.1 MODIFICATION AND SPECIAL INSPECTIONS

Significant modifications and special inspections that were accomplished on stage S-IB-5 during the modification and refurbishment period are covered in Section II of this supplement.

### 1.4.2 SHAKEDOWN INSPECTION

Upon completion of the modification and refurbishment period, just prior to movement of the stage into the functional checkout complex, shakedown inspection was performed to assure that all stage components and hardware were in acceptable condition and installed in conformance with applicable drawings and specifications. Significant failures and discrepancies found are covered in Section IV.

## 1.5 POST STORAGE REVERIFICATION CHECKOUT

1.5.1 Post storage reverification checkout was begun on 28 December 1967 and completed on 13 March 1968. These functional checkout operations were conducted to insure that

stage S-IB-5 was man-rated at time of shipment to KSC. Information and pertinent data regarding post storage reverification checkout are related in Section III. Failures and discrepancies encountered are included in Section IV.

1.5.2 During post storage reverification checkout, flight accelerometers, engine pressure transducers, antenna assemblies, and rate gyros, which had been temporarily removed, were reinstalled on the stage.

## 1.6 PREPARATION FOR SHIPMENT TO KSC

After completion of post storage reverification checkout, the stage was moved into the preparation-for-shipment area. Preparing stage S-IB-5 for shipment to KSC consisted of the following operations:

a. Cleaning the entire stage and painting where necessary

b. Final shakedown

c. Installing heat shield panels and flame curtains

d. Installing components for environmental protection

e. Installing erection hardware

f. Installing shipping instrumentation

g. Installing road preservation items and positioning transportation dollies

### 1.6.1 CLEANING AND PAINTING

1.6.1.1 Functions performed for cleaning the stage consisted of thoroughly cleaning and vacuuming the instrument compartments, top-tank area, and tail section compartments. Removal of loose particles and dirt from corners and recesses was accomplished by multiple rotations of the stage. The exterior

surfaces were cleaned using a non-ionic detergent and areas that required paint touchup were noted.

1.6.1.2 Paint touchup of interior compartments of the stage was accomplished by applying zinc-chromate at worn areas as required. Areas noted during cleaning of the exterior surfaces as needing paint touchup were touched up. Painting was accomplished as specified by paint pattern drawing 60C10349.

## 1.6.2 FINAL SHAKEDOWN

1.6.2.1 The entire stage was given a thorough shakedown by manufacturing personnel. Thorough checks were made to assure that all discrepancy documents were cleared, modifications completed, and components that required removal during post storage reverification checkout were properly reinstalled.

1.6.2.2 Final shakedown inspection was then performed by CCSD and NASA inspectors and enclosed areas were sealed off. Discrepancies found were resolved prior to shipment. Those significant discrepancies found during preparation for shipment are described in Section IV and modifications in Section II.

## 1.6.3 INSTALLATION OF HEAT SHIELD PANELS AND FLAME CURTAINS

The flight heat shield panel assemblies and outboard engine flame curtains that had been removed to facilitate access for modification and checkout were reinstalled during preparation for shipment. These components combine with the engine heat shields and the flame shield support assembly that were installed prior to in-house storage to provide thermal insulation for the boattail area.

### 1.6.4 INSTALLATION OF ENVIRONMENTAL PROTECTION

Environmental protection was provided in accordance with those requirements of MSFC specification 60C06019 that are related to preparation for shipment. Desiccant was replaced whenever the humidity indicators indicated a relative humidity of 30 percent or higher. Protective covers for flexible ducting bellows at sliding and gimbal joints were removed, and the joints were thoroughly cleaned and checked to assure that no foreign materials were trapped in the bellows convolutions. After cleaning, the covers were reinstalled. Vent openings in all propellant containers were closed with vapor barrier material conforming to Specification MIL-B-131 and secured with tape. Doors were installed for each umbilical plate and taped closed, followed by the installation of protective caps on all unmated electrical connectors on the stage. Non-flight items were tagged with adhesive-backed or tie-on tags conforming to Specification 10C01682 which specifies that all items that must be removed be tagged to assure none are overlooked prior to launch. Remaining environmental protection items were installed as specified on drawing 60C11673.

### 1.6.5 INSTALLATION OF ERECTION HARDWARE

After installation of environmental protection items, the erection beam, erection brackets, and hardware necessary for erection of the stage in the launch pedestal were installed as specified by drawing 60C10704. To install the erection hardware, it was necessary to remove the aft tooling ring, five sections of the forward tooling ring, and the captive-fire fittings. Following removal of the aft tooling ring, the shipping ring was installed.

### 1.6.6 INSTALLATION OF SHIPPING INSTRUMENTATION

This operation consisted of the installation of an event/environmental recording device, accelerometers, and a temperature and humidity sensing module as directed by instrument installation drawing 60C11660. Constant monitoring of vehicle

environmental conditions during shipment is the primary purpose of shipping instrumentation.

### 1.6.7 INSTALLATION OF ROAD PRESERVATION ITEMS AND TRANSPORTATION DOLLIES

Prior to stage shipment, ten desiccant retainers were charged with activated silica-gel and installed into the boattail area which was then closed by installing the one remaining heat shield panel. The sequence of desiccant installation was planned so as to avoid prolonged exposure of silica-gel units. Pipe connectors and flexible tubing extensions were connected from the lox and fuel breather assemblies to be later attached to barge breather cans. Also, the 60C11309 center plastic cover was wrapped around the stage to protect the black painted areas on the 70-inch fuel containers from direct sunlight. Subsequent to the aforementioned operations, transportation dollies were positioned under the stage and the tow vehicle attached.

## 1.7 SHIPMENT TO KSC

Upon completion of the foregoing operations, final buyoff was accomplished. The stage was then moved from the preparation-for-shipment area in MAF to the exit door. CCSD Systems Test Department, Transportation Branch, assumed control and responsibility at this point and transported the stage to the barge for loading. Stage S-IB-5 was shipped to KSC on 25 March 1968.

# SECTION II

# MODIFICATIONS AND SPECIAL INSPECTIONS

## 2.1 SCOPE

2.1.1 After stage S-IB-5 was moved to in-house storage and prior to shipment to KSC, a number of major and minor modifications and special inspections were incorporated and/or performed. The intent of this section is to list, briefly explain, and show authorization for the modifications and special inspections that are significant. It should be noted that the majority of these processes would normally have been conducted during prelaunch operations at KSC, but due to the extended length of the storage period, they were rescheduled and performed by CCSD at MAF.

2.1.2 In sequence based on related systems and chronology, significant modifications are described in the paragraphs under heading 2.2, followed by special inspections in paragraphs under heading 2.3. In those paragraphs that contain reference to a previously published Assembly and Test Report or supplement, the initial and/or more comprehensive coverage is provided in the referenced publication. The reference will include the paragraph number within the indicated publication which will provide additional information as needed in regards to the subject matter.

2.1.3 In instances where system components were removed from the stage and modified or inspected, component level retest was accomplished prior to reinstallation. Systems which incurred any form of modification or removals for inspection prior to or during post storage reverification checkout were verified and accepted during functional checkout test. Modifications and/or inspections requiring system retest at KSC are listed in table 5-6 and the requirement is stipulated in the applicable narrative paragraph.

## 2.2 SIGNIFICANT MODIFICATIONS

### 2.2.1 SPRING WASHER REMOVAL

Just prior to movement to in-house storage, spring washers were removed from all MF fittings on pneumatic tubing and flexible hose assemblies in stage S-IB-5. Cracked spring washers had been found in MF fittings of several S-IB stages; therefore, investigation for corrective action was initiated. To provide a temporary fix, spring washers were removed from MF fittings on all stages through S-IB-12 and the fittings were secured with lockwire.

Reference: ECP ET-11799 and paragraph 4.3.2.3 in S-IB-7 Assembly and Test Report, RB-B7-EIR-5.1

### 2.2.2 TEST OF HAZARDOUS GAS DETECTION SYSTEM

The hazardous gas detection system was incorporated into stage S-IB-5 during operations prior to in-house storage (ECP ET-11818). This system consists of tubing networks terminated by sniffing devices which are used to determine the presence of hazardous (combustible) gas in stage areas during prelaunch operations. Portions of the hazardous gas detection system are located in the S-IB/S-IVB interstage area, the engine area, and in the aft skirt of each lox container. Subsequent to movement of the stage to in-house storage, the system was functionally tested.

Reference: AIECR P-2100

### 2.2.3 TEST OF FUEL CONTAINER VENTING SYSTEM

Qualification testing of 10C10233 fuel safety relief valve adapter plates revealed that the adapter plates would amplify vibrations and as a result, become deformed. ECP ET-11878 was initiated and approved directing that all 10C10233 adapter plates be replaced by improved 60C12033 adapter plates on S-IB-4 and subsequent stages. This was accomplished on stage S-IB-5 prior to movement to in-house storage. During storage,

tests were conducted to verify the leak-tight integrity of the fuel container venting system. Satisfactory results were achieved.
Reference: AIECR P-2099

## 2.2.4 MODIFICATION OF RDSM (9A700)

2.2.4.1 RF Bonding. Subsequent to movement to in-house storage, RDSM (9A700) 50C12088-3, serial number 008, was removed, updated to improve the RF bonding, and reinstalled. Updating consisted of installing a larger bonding strap and finishing all mounting surfaces of the RDSM in accordance with Specification MIL-M-3171.
Reference: ECP ET-11888

2.2.4.2 Heat Sink Modification. At a later date during storage, RDSM serial number 008 was again removed and updated by applying a thin coat of heat sink compound to the interior and exterior of the threaded portion of the heat sink. This was accomplished in order to increase power supply reliability and decrease cross-talk in the 3.6-khz synchronization line. After modification, the RDSM was reinstalled.
Reference: ECP ET-51204R1

2.2.4.3 Power Supply Design Change. During preparation for shipment to KSC, RDSM serial number 008 was removed from the stage for update to incorporate power supply design change. The 50M11924-1 power supply PWA was removed from the assembly to be replaced by an updated PWA 50M11924-3. However, prior to installation, several nonconformances were discovered on the updated PWA (refer to paragraph 4.2.3.7). In compliance with WAN 165, revision P, and GFP Rework Work Order 68-3-416, the PWA was reworked to a configuration usable for test, and the RDSM was tentatively reinstalled though tagged "not for flight use". The unflightworthy PWA is to be replaced at KSC when an acceptable-for-flight item is made available.
Reference: ECP EP-51281R1

## 2.2.5 ACTUATOR BETA POTENTIOMETER REPLACEMENT

2.2.5.1 Due to a design deficiency causing repeated failures, a modification of actuator beta potentiometers in the 60C60001 servo actuators was accomplished affecting stages S-IB-4 through S-IB-12. Obsolete 062-42282 potentiometers, with internal printed circuit cables, were replaced in each actuator by updated 062-45512 potentiometers utilizing individual insulated wires in place of the printed circuit cables.
Reference: ECP ET-40538R3 and paragraph 5.3.3.17 in S-IB-6 Assembly and Test Report, RB-B6-EIR-5.1

2.2.5.2 During in-house storage of stage S-IB-5, obsolete potentiometers were replaced by updated potentiometers as indicated in the 062-42282 entries in table 5-1; however, a potting discrepancy was later discovered in the updated potentiometers which necessitated additional replacement and rework (refer to paragraph 4.2.3.1).

## 2.2.6 ODOP TRANSPONDER (13A498)

Based on inspection and test information received from vehicle AS-201, there were indications that internal components of the 50C12181 ODOP transponder (13A498) were not properly secured. To insure reliability, it was necessary to subject all ODOP transponders to vibration and electrical acceptance tests in accordance with procedure 50C60024. During storage of stage S-IB-5, ODOP transponder serial number 29 was removed for test and replaced by serial number 31 which had previously undergone testing.
Reference: WAN 150A

## 2.2.7 STRUCTURAL IMPROVEMENT OF 70-INCH LOX CONTAINERS

During storage, a major structural modification was incorporated into the 70-inch lox containers in order to reduce peaking stress in the cylindrical section of the containers. In the forward skirt of each lox container, strengthening members were added and the existing aluminum fasteners were replaced by

steel fasteners of a larger size. This modification also involved the removal and reinstallation of critical components in the forward end of the stage and rerouting of pneumatic tubing and electrical harnesses.

Reference: ECP ET-30867R1 and paragraph 1.3.1 in S-IB-6 Assembly and Test Report, Supplement 1 RB-B6-EIR-5.1

## 2.2.8 BALL-ROTOR VALVES

2.2.8.1 Cast Aluminum Flange Coldshuts. Due to leakage encountered through the cast aluminum flange of one ball-rotor valve during prelaunch operations of stage S-IB-4 at KSC, visual inspection was performed on all S-IB stages to detect coldshuts in cast aluminum flanges of all ball-rotor valves in use. Numerous coldshut conditions were found. Therefore, those valves with coldshuts were removed from the respective stages and pressure tested to 225 psig in order to assure leak-tight integrity. During storage of stage S-IB-5, five valves exhibiting coldshuts (60C26025-1, SN 102; 60C20339, SN 147; 60C20340, SN 146, SN 154, and SN 156) were removed from the stage, pressure tested, found acceptable, and reinstalled.

Reference: Paragraph 1.5.2 in S-IB-6 Assembly and Test Report, Supplement 1, RB-B6-EIR-5.1

2.2.8.2 Control Piston Housing Cracks.

2.2.8.2.1 Stress corrosion cracks were encountered in the 2632793 control piston housing of ball-rotor valves during prestatic functional checkout operations of stage S-IB-8. As part of the ensuing investigation, the two S-IB-5 fill and drain valves (fuel 60C26025-3, SN 101; and lox 60C26025-1, SN 101) were removed for inspection and replaced (fuel SN 112 and lox SN 102). This was accomplished during in-house storage.

2.2.8.2.2 Investigation and test revealed that the high torque value required at the control piston fitting (270 to 300 inch-pounds) was causing stress corrosion cracking. To correct this situation, it was necessary to replace the existing K-seals with O-rings and specify a lower torque value (30 to 50 inch-pounds) since O-rings will seal with a much lower torque.

This was accomplished by modification during storage of stage S-IB-5, and on all stages through S-IB-12.
Reference: ECP ED-21029R1 and paragraph 5.3.2.1 in S-IB-8 Assembly and Test Report, RB-B8-EIR-5.1

## 2.2.9 INSTRUMENTED MOUNTING STUDS

2.2.9.1 During storage, the 30C00430 mounting studs that connect the 70-inch lox containers to the spider beam were replaced by 30C00595 instrumented mounting studs. These studs will be utilized for recording and determining the bending moment of the vehicle while stationed in the launch pedestal at KSC. Refer to the 30C00430 entries in table 5-1 for serialization of replacement 30C00595 mounting studs. 30C00430 studs are not serialized.
Reference: ECP EP-51171 and paragraph 1.3.6 in S-IB-6 Assembly and Test Report, Supplement 1, RB-B6-EIR-5.1

2.2.9.2 After incorporation of instrumented mounting studs on stages S-IB-5 through S-IB-12, it was found on stage S-IB-10 that a wiring error had been incorporated by ECP ET-51171. It was necessary to correct this error on all affected stages. Stage S-IB-5 was corrected during storage by installing a modified 12W52 cable assembly followed by acceptable electrical tests.
Reference: ECP ET-40682 and paragraph 5.3.3.10 in S-IB-7 Assembly and Test Report, RB-B7-EIR-5.1

## 2.2.10 TM ASSEMBLY (13A450)

2.2.10.1 Moisture Sealing. During storage, the 13A450 TM assembly 60C50142, serial number 001, was removed from instrument compartment 1 for updating. Gaskets were installed in all miniature electrical connectors to aid in moisture sealing the interface between plugs and receptacles. After updating, the TM assembly was reinstalled during the modification and refurbishment period.
Reference: ECP ET-51254

2.2.10.2 Input Impedence. During preparation for shipment, TM assembly serial number 001 was removed to facilitate input impedence test of TM oscillator assembly 50M60100. The input impedence test procedure had been revised specifying utilization of an improved test set up. Subsequent to testing oscillator impedence, TM assembly serial number 001 was submitted to a complete functional test and reinstalled on the stage. System verification test will be accomplished during normal prelaunch operations at KSC.
Reference: ECP ET-51325

## 2.2.11 DISTRIBUTOR MODIFICATIONS

2.2.11.1 Prevalve Control Modification. During storage, the 9A1 and 9A2 propulsion distributor assemblies were removed, updated, and reinstalled. In order to prevent premature prevalve closure and possible severe engine malfunction, the propulsion distributors were electrically modified so that the prevalves will be controlled only by the TOP switches. This modification was prompted by an explosion, experienced while testing an F-1 rocket engine, which was caused by premature prevalve closing.
Reference: ECP EP-40667

2.2.11.2 Removal of Relay Contacts. Propulsion distributor assemblies 9A1 and 9A2 were again removed during storage in order to eliminate cutoff relay contacts from the prevalve control valve circuits. The propulsion distributors were reinstalled during the modification and refurbishment period at which time shock mounts, new hanger assemblies, and brackets were added to implement the requirements to provide a 100-microsecond limit on relay contact chatter duration.
Reference: ECP EP-40867R1 and ECP EP-40653R1

2.2.11.3 Separation System Modification. Main distributor assembly 12A1 was removed during storage, updated to provide redundancy for the separation system, and subsequently reinstalled. Electrical modification provided two independent control circuits so if one circuit was to fail during the mission, separation would be controlled by the alternate circuit.
Reference: ECP EP-40656R1

2.2.11.4 Receptacle and Ground Stud Modification. During storage, power distributor assembly 12A25 was removed, updated, and reinstalled. Updating consisted of torquing distributor receptacle jam nuts to higher values to prevent receptacles from turning and causing internal distributor damage while attaching the mating connectors. Also, two MS35337-103 lockwashers were added to each of the two ground studs on the distributor to prevent loosening of the ground studs while disconnecting the ground cables.
Reference: ECP ET-40663 and ECP ET-40662

2.2.11.5 Changeout of Four-Pole Relays. Late in the storage period, main distributor assembly 12A1 and power distributor assembly 12A25 were again removed to accomplish changeout of four-pole relays (Union Switch and Signal Company S4GH-2-22 and -22A) which had failed qualification test. After modification, the distributors were reinstalled. Three relays were removed from the 12A1 distributor and replaced by three S6GH-2-1 relays and five relays were removed from distributor 12A25 which were replaced by three S6GH-2-1 relays and two 40C32021 suppressor assemblies.
Reference: ECP ET-40694R1, PAN 17, and paragraph 2.2.13.2.10 in S-IB-8 Assembly and Test Report, RB-B8-EIR-5.1

2.2.11.6 Elimination of Measurements K161-13 and K162-13. During storage, measuring distributor assembly 12A26 was removed from the stage, updated to eliminate the circuitry for measurements K161-13 and K162-13, and subsequently reinstalled. Range safety decoder measurements K161-13 and K162-13 are no longer required for flight evaluation.
Reference: ECP EP-51214

## 2.2.12 BLUE PLASTIC CENTER COVER

In order to prevent buckling of stage structures due to temperature differences between the black and white painted areas when exposed to direct sunlight, the 60C11309-1 blue plastic center cover was installed to envelop stage S-IB-5 during storage. This cover was removed during the modification and refurbishment period and reinstalled prior to shipment to KSC. It should be noted that all propellant containers are

painted white on S-IB-6 and subsequent stages as corrective action against possible buckling due to temperature differences.
Reference: ECP EP-11424R1

### 2.2.13 POSITION-INDICATING SWITCHES, FUEL VENT VALVES

During storage, the 60C00423 push switches (position indicating) were removed from the two 60C21490 fuel vent valve assemblies in fuel containers 3 and 4 and replaced by updated push switches. This change was necessary due to switch failure at low temperature during environmental qualification tests.
Reference: ECP ET-21007

### 2.2.14 CALIBRATION VALVE

Numerous 50C10377 calibration valve malfunctions on stage S-IB-9 prompted investigation which disclosed that one lot of 86 calibration valves had been improperly lubricated by the vendor. The improper lubricant (KEL-F-90 instead of the specified FS1280/81) was adversely affected when the valves were flushed with freon which washed away the oils in the lubricant causing the valve poppets to seize. All 86 calibration valves were traced, purged from stock or replaced on the respective stages, and subsequently reworked. Calibration valve serial number 2662, in S-IB-5 measurement D14-6, was one of the defective valves and was therefore replaced by serial number 1307 during storage.
Reference: PAN 10 and paragraph 1.3.5 in S-IB-6 Assembly and Test Report, Supplement 1, RB-B6-EIR-5.1

### 2.2.15 SERVO ACTUATOR PAINTING

During in-house storage, the eight 60C60001 servo actuators were cleaned and painted in compliance with procedure 60C66001. This was accomplished to provide a protective coating on the actuators to avoid stress corrosion.
Reference: ECP EP-40684

## 2.2.16 GEARCASE PRESSURIZATION MANIFOLD ASSEMBLY

2.2.16.1 During S-IB-4 prelaunch operations at KSC, RP-1 fuel and lubricant was detected on the lox side of the NA5-28151-1 gearcase pressurizing check valve on engine 4. As a result, NASA directed that the gearcase pressurizing cross, check valve, and manifold assembly be inspected for contamination on each rocket engine assembly installed on current S-IB stages. A swab inspection of the engines on stage S-IB-5, conducted during storage, was acceptable.

2.2.16.2 As a preventive measure against seepage of engine hydrocarbons through the gearcase pressurizing cross while the S-IB stage is in the horizontal position, all NA5-28151-1 check valves and 556345 plug assemblies were removed, packaged, and added to the shipped-loose items for stage shipment. The gearcase cross fittings and purge manifold assemblies were then capped and plugged. The gearcase pressurizing/lox seal cavity purge system will be reconnected only at times when needed during engine tests performed on loose engines or during functional checkout, static firing, or launch operations.

Reference: ECP EP-21006R3 and paragraph 4.3.2.11 in S-IB-6 Assembly and Test Report, RB-B6-EIR-5.1

## 2.2.17 EBW FIRING UNITS

2.2.17.1 Output Cable Lengths. Near the end of the S-IB-5 storage period, eight 40C39515-105 EBW firing units (retrorocket) were replaced in the forward end of the stage by eight 40C39515-119 EBW firing units. This was accomplished in compliance with NASA direction to utilize EBW firing units with 36-inch long output cables as opposed to the existing units with 30-inch long output cables. For serial numbers of removed and installed units, consult the 40C39515 entries in table 5-1.

Reference: ECP ED-40618 and WAN 102C

2.2.17.2 Excessive Operating Cycles.

2.2.17.2.1 The operation of EBW firing units was formerly recorded in running time; however, a revision to the log books supplied with each unit recorded operation by number of cycles. Extensive correspondence between CCSD and NASA resulted in issuance of a NASA directive specifying that EBW firing unit operation be recorded by operating cycles, effective for stages S-IB-4 through S-IB-12. The limit of operating cycles was established to be 1000 cycles.
Reference: WAN 108A

2.2.17.2.2 It was determined that during prestatic and post-static functional checkout operations, the two 40C39515-111 propellant dispersion EBW firing units, serial numbers 429 (11A43) and 430 (11A42), had operated in excess of 4000 cycles. This was due to continuous exitation having been applied to the units for approximately 15 minutes during each checkout. While the stage was undergoing modification and refurbishment, the two units were replaced by 40C39515-123 firing units, serial numbers 495 (11A43) and 531 (11A42). Newer 40C39515-123 EBW firing units are interchangeable with the -111 units which are no longer available.
Reference: ECP EP-40728

2.2.17.2.3 Functional checkout test equipment circuitry has been revised in order to limit the number of trigger pulses to the EBW firing units and to provide an accurate count of the number of operating cycles instead of running time.

## 2.2.18 AGE-CONTROLLED ITEMS

During the modification and refurbishment period, all age-controlled items that contained elastomers with six months or less unexpired life were removed and replaced or refurbished and reinstalled. Data pertaining to replacement components in this modification are provided in table 5-1. Further information regarding age-controlled items, including an extension of the installed life of synthetic rubber goods, is related in paragraph 5.1.2.2
Reference: WAN 165I

## 2.2.19 FIRST-MOTION TARGETS

During the modification and refurbishment period, first-motion targets were painted on the tail section of stage S-IB-5. First-motion targets consist of three contrasting color stripes, 10 inches long by 2 inches wide, on 12-inch centers. The targets are located on the tail section at station 54 to 80.
Reference: ECP EP-11987

## 2.2.20 FUEL DEPLETION SENSORS

During modification and refurbishment, the 60C20003 fuel depletion sensors were removed from the fuel-2 and fuel-4 container unit assemblies and replaced by 60C21690 fuel depletion sensors. This was accomplished to eliminate premature sensor actuation caused by bubbles in the fuel as had been encountered during flight of vehicles AS-201 and SA-203. The new configuration 60C21690 sensors had been used during flight of vehicle AS-202 and were found to function properly.
Reference: ECP EP-11850R4

## 2.2.21 SERVO ACCELEROMETER UNITS

The 50C10384 servo accelerometer unit for measurement A7-12 and the two 50C10286 servo accelerometer units for measurements A53-11 and A54-11 were removed from measuring rack 12A439 during the modification and refurbishment period, updated, recalibrated, and reinstalled. Modification consisted of applying locktite to threads of one transformer nut on the internal printed wiring assembly to prevent loosening.
Reference: ECP ET-51258

## 2.2.22 VENTED TOP SWITCH CHECKOUT CIRCUIT

During the modification and refurbishment period, one 20C30141 QD nipple was replaced by a 60C22140 QD coupling half at the lox-4 lower umbilical plate. This was accomplished to provide a vented TOP switch checkout circuit to prevent the possibility of all the TOP switches being rendered inoperative

if the calibration diaphragm is ruptured on one switch during flight.
Reference: ECP EP-11977

## 2.2.23 WATER QUENCH SYSTEM

2.2.23.1 Corrosion had been discovered in water quench valves 60C20894 caused by inadequate drying procedures following hydrostatic test at MAF. It was decided to remove the water quench valves from all S-IB stages, logistics, and in-house stores for disassembly, inspection, and refurbishment. After refurbishment, the valves were reinstalled on the stages in scheduled sequence. Corrective action consisted of generating QCI 55226 to provide instructions for thorough draining of the valve after hydrostatic test and verification in the valve clean room that the valve is dry and clean.

2.2.23.2 The four water quench valves were removed from stage S-IB-5 during the modification and refurbishment period. Upon removing the valves, a large piece of wrapping paper and flakes of ferrous corrosion products were found in the water quench system piping. Consequently, the entire water quench system was submitted to thorough inspection and cleaning prior to reinstallation of refurbished valves. Refer to the 60C20894 entries in table 5-1 for serialization of removed and replaced water quench valves. Further corrective action consisted of revising in-house packaging procedures to incorporate plastic flange caps and wrap with a heat-sealable vapor barrier material, effective on S-IB-13 and subsequent stages. In addition, the use of Kraft wrapping paper was discontinued because it contains sulfur and could contribute to corrosion of a wrapped component.
Reference: PAN 32, PAN 32A, WAN 261, and WAN 261A

## 2.2.24 HYDRAULIC FLUID CHANGEOUT

2.2.24.1 During the modification and refurbishment period, the existing MIL-H-5606B hydraulic fluid was removed from the hydraulic systems and replaced with Brayco 757B hydraulic fluid which contained a corrosion inhibitor. Brayco 757B hydraulic fluid meets all the requirements of Specification MIL-H-5606B. Work was accomplished in compliance with QCI 50024.

2.2.24.2 Past history of S-IB stage hydraulic systems has shown that rust or silt less than 10 microns in size will collect in the servo valve of the 60C60001 servo actuators causing erratic system operation. Silt cannot be removed from the fluid by filters in the on-board systems and therefore, must be prevented from forming.
Reference: ECP ET-21089, Technical Bulletin TB-P&VE-66-219, and paragraph 6.5.5 in the basic publication

## 2.2.25 LOX COMPATIBILITY

Following a lox compatibility review conducted by NASA at MSFC, a similar extensive review was performed by CCSD Materials Engineering as requested by NASA. In order to satisfy the lox/gox requirements of MSFC-Specification-106, modifications were accomplished during the modification and refurbishment period as described in the following sub-paragraphs.

2.2.25.1 Gox System. The 60C20129 butterfly gox control valve, serial number B432110, was removed from the stage for changeout of packing (O-rings). The existing packing was replaced by Viton packing. Following control valve rework (refer to paragraph 4.2.2.8) and prior to reinstallation, Viton packing was installed into the gox manifold and into the associated 60C10536 pressure transducer assembly.
Reference: ECP EP-21073R1 and ECP EP-11973

2.2.25.2 Lox Vent and Relief Valve. The 60C21404 lox vent and relief valve, serial number 891, was removed from the stage for updating which consisted of applying type-III polyurethane (MSFC-Specification-202) to the valve housing and position-indicating switch in accordance with MSFC-Procedure-186. Updated lox vent and relief valve serial number 770 was installed on the stage as the replacement.
Reference: ECP EP-21078

2.2.25.3 7-Inch Lox Vent Valves. The 60C21263 gox venting assemblies, serial numbers 0017 (lox 2), C0001 (lox 3), and C0004 (lox 4), were removed to facilitate replacement of all seals and gaskets with lox compatible material in the integral

7-inch lox vent valves 20C30122. After rework, serial number 0017 was reinstalled in container unit assembly, lox 2. In lox 3 and lox 4 however, updated replacement assemblies, serial numbers 1382 and 1250, were installed respectively.
Reference: ECP EP-21075

2.2.25.4 Lox Overfill Sensors. The spider beam seal plates were removed to facilitate the application of a protective coating over the lox sensitive epoxy inside the 60C20238 lox overfill sensors. The sensors were coated with PR1732 primer and D4327 sealant which is lox compatible.
Reference: ECP EP-21072

2.2.25.5 System Components. At the umbilical plates, four 0.25-inch QD couplings 20C30138 were replaced by similar couplings with Viton seals. Refer to table 5-1 for serial numbers removed and replaced. In addition, Viton packing was installed between the four 50C10377 calibration valves for the D13 measurements and their associated adapters on the outboard engines.
Reference: ECP EP-21076R2

## 2.2.26 FUEL SAFETY RELIEF VALVES

During the modification and refurbishment period, the 60C21490 fuel safety relief valves serial numbers 14 and 11 were removed from fuel-3 and fuel-4 container unit assemblies respectively for updating. Due to failure of the subject valves on other stages caused by contamination with RP-1 fuel, unlubricated teflon poppet seals and a stiffer main poppet spring were incorporated to provide more reliable operation that would not be affected by the presence of fuel contaminants. After updating, serial number 11 was reinstalled and an updated replacement valve, serial number 0014 was installed in fuel 3.
Reference: ECP ET-21086

## 2.2.27 7-INCH LOX VENT VALVES

Just prior to movement of the stage to post storage reverification checkout, the three 60C21263 gox venting assemblies were removed for updating of the 20C30122 7-inch lox vent valves.

Recent qualification test results had indicated that the existing spring in the shaft seal, fabricated of 17-7PH CRES, is too brittle and will break under vibration, causing leakage. Modification consisted of replacing the existing shaft seal spring with a spring fabricated of 304 CRES. This changed the part number of the shaft seal from 60C22091 to 60C22330. Following modification, the vent valves were reassembled and the gox venting assemblies were reinstalled at their original stage positions.
Reference: ECP ET-21120CCR2

## 2.2.28 BUTTERFLY GOX CONTROL VALVE

During functional checkout of stages S-IB-6 and S-IB-12, the 60C20129 butterfly gox control valve malfunctioned caused by low torque on the associated aneroid cover fasteners. To prevent this occurrence on stage S-IB-5, fastener torque was checked and tightened as necessary on the aneroid cover of control valve serial number B432110. This was accomplished in accordance with QC Engineering direction during post storage reverification checkout and was necessary on all valves that had been modified in compliance with ECP ET-21073R1 (refer to paragraph 2.2.25.1). Proof-pressure (105 psia) was then applied to the valve to cause the aneroid to set properly. QCI 62661 has been revised to require application of proof-pressure following valve disassembly and reassembly.
Reference: FFADS 1913 (S-IB-6)

## 2.2.29 SPECIAL PROTECTIVE COVERS

Originally, as a result of investigation by CCSD Human Factors Engineering in late 1966, non-flight protective covers were installed over the TOP switches and hypergol igniter monitor switches on S-IB-6 and subsequent stages. This was accomplished due to extensive damage to the subject switches caused by personnel working in the engine area. Since stage S-IB-5 had completed scheduled assembly and test operations and was in storage at the time, these covers were not installed. However, due to the extensive additional operations that were necessary subsequent to storage on stage S-IB-5 and damage that occurred during these operations (refer to paragraphs

4.2.1.12, 4.2.1.13 and 4.3.1.2), covers were fabricated and installed. The TOP switch covers and inboard engine hypergol igniter monitor switch covers were installed during post storage reverification checkout. The outboard hypergol switch covers were installed as part of preparation for shipment operations.
Reference: Paragraph 5.3.1.1 of S-IB-6 Assembly and Test Report, RB-B6-EIR-5.1

## 2.2.30 HEAT SHIELD MODIFICATION

2.2.30.1 Engine Heat Shields. During post storage reverification checkout, Rocketdyne personnel removed the vapor barrier coating from the ceramic insulation on the aft side of each engine heat shield between the heat exchanger and thrust chamber throat. This was accomplished in accordance with Rocketdyne ECP H1-326 to eliminate a potential safety hazard. CCSD and NASA provided surveillance and inspection during this modification.
Reference: GFP Rework Work Order 68-1-407

2.2.30.2 Stage Heat Shields. During preparation for shipment, CCSD removed the M-31C protective coating from the entire heat shield area on the stage in order to comply with safety discipline. This, combined with the removal of vapor barrier material from the rocket engine assemblies, eliminates a potential fire hazard.
Reference: ECP ED-30986R1

## 2.2.31 LOX QUICK DISCONNECT COUPLING NOZZLE

While preparing the stage for shipment, the 20C30202 lox quick disconnect coupling nozzle was removed from lox-3 container unit assembly to facilitate gasket replacement. In order to decrease leakage potential, a Narmco gasket 60C12100-1 was installed to replace the existing Alpax 20C00870-8 gasket after which the coupling nozzle was reinstalled and torqued. Prelaunch verification test is required at KSC.
Reference: ECP ET-11895CC

## 2.3 SPECIAL INSPECTIONS

### 2.3.1 ROCKET ENGINE INSPECTIONS

2.3.1.1 Turbopump Inspection. While Rocketdyne personnel were performing turbopump calibration and H-1 engine testing at Rocketdyne-Neosho, turbopump lube oil seal leakage was discovered. After investigating the condition, it was determined that when the 455241 shaft locking sleeve was tightened, the 453978 sleeve retaining lockwasher would fail. The resultant interference between the sleeve and lube oil seal mating ring caused the aforementioned leakage. The discrepant condition necessitated that all engines associated with stages S-IB-4 through S-IB-11 be subjected to a special inspection (refer to Rocketdyne Engine Field Inspection Request H1-7). After movement to in-house storage, the S-IB-5 engines were inspected by removing the lox seal drain connection at the gearcase turbopump and inserting a borescope through the primary lox seal drain port. The sleeve retaining lockwasher was in the correct position on all engines. The lox seal drain connection was then reinstalled.
Reference: GFP Rework Work Order 66-10-155

2.3.1.2 Clearance Measurements. CCSD furnished QC inspection surveillance during storage to assist Rocketdyne Engineering in establishing an average distance between the gas generator igniter bosses and turbine exhaust hood on each rocket engine assembly. The average distance established on stage S-IB-5 was found to be 3.509 inches which has been determined by Rocketdyne to be sufficient.
Reference: GFP Rework Work Order 66-8-100

2.3.1.3 Lox and Lube Seal Cavities and Drain Lines.

2.3.1.3.1 Due to the discovery of moisture and corrosion products in the lox and lube seal cavities of four outboard engines on stage S-IB-11 and in compliance with government direction, CCSD performed swab checks of the lox seal cavities and drain lines on each S-IB-5 engine and all engines on other stages to reveal and subsequently analyze any moisture and corrosion products. The swab checks indicated that all S-IB-5 engines were free of moisture and corrosion products.
Reference: GFP Rework Work Order 67-3-265 and PAN 18

2.3.1.3.2 The moisture found in the engines of other stages was analyzed to be ethylene glycol, a constituent of leak-detector solution (MSFC-Specification-384) which had drained into the engine cavities and subsequently caused corrosion. A large contributing factor to the problem had been the use of rubber plugs in the drain lines which did not allow the moisture to evaporate or drain out. Inspection during storage revealed that these rubber plugs had not been installed in the engines of stage S-IB-5; proper polyethylene bags were used (refer to ECP ET-21080).
Reference: GFP Rework Work Order 67-4-286

2.3.1.3.3 At a later date during storage, a major special inspection was conducted in the rocket engines in accordance with a comprehensive inspection program by Rocketdyne with CCSD and NASA support and/or surveillance. Rocketdyne Engine Field Inspection Request H1-19A was performed on each S-IB-5 engine. This inspection consisted of disconnecting the lox and lube seal drain lines for visual inspection, borescope inspection of the lox seal cavities, and a suction sweep of the lox and lube seal cavities. Only minor hardware damage was revealed while inspecting the S-IB-5 engines (refer to paragraph 4.2.2.15); no moisture or corrosion products were found.
Reference: GFP Rework Work Order 67-7-319 and paragraph 4.3.2.24 in S-IB-7 Assembly and Test Report, RB-B7-EIR-5.1

2.3.1.4 Turbine Wheel Inspection. During modification and refurbishment, representatives of Rocketdyne and Union Carbide Corp. performed inspection of each rocket engine assembly to verify that the specified material had been used in fabrication of first-stage turbine wheel blades. It was necessary for Rocketdyne to remove the test plate or protective closure from the SPGG attach flange on the GG combustor to facilitate inspection in compliance with Rocketdyne Engine Field Inspection Request H1-11B. Inspection verified that the proper Haynes Stellite 21 material had been used in the first-stage turbine wheels of all S-IB-5 engines. After inspection, the SPGG closures were reinstalled.
Reference: GFP Rework Work Order 67-4-279, revision 2 and paragraph 6.6.2.3 in S-IB-8 Assembly and Test Report, RB-B8-EIR-5.1

2.3.1.5 Thrust Chamber Inspection. Corrosion was discovered on the outer skin of the thrust chamber of each rocket engine assembly on stage S-IB-4 at KSC. As part of the ensuing investigation, it was directed by CCSD Engineering to inspect the thrust chambers of the S-IB-5 engines to determine if a similar corrosion condition existed. Accordingly, the protective covers were removed and the engines were thoroughly inspected during the modification and refurbishment period; no corrosion was found.

## 2.3.2 TITANIUM SPHERE INSPECTION

It has been determined that the destruction of an S-IVB stage was caused by explosion of a titanium high-pressure sphere because the sphere was fabricated using an incorrect filler wire (welding rod). The vendor of titanium high-pressure spheres for S-IB stages is not the same vendor who supplied the defective S-IVB sphere. However, in compliance with NASA direction, a special eddy-current inspection was made of the weld material in the 60C20001 fuel pressurization spheres on all current S-IB stages. Inspection of the titanium spheres on stage S-IB-5 was conducted during storage and the weld material was determined to be correct. In addition, research of vendor records revealed that incorrect filler wire had never been used.

## 2.3.3 AUXILIARY PUMP MOTOR RADIOGRAPHIC INSPECTION

Due to malfunction of the MS1350-310-161 thermal switch in the 60C20847 auxiliary pump motors during static test of stage S-IB-9, radiographic inspection was conducted on all 60C20739 and 60C20847 auxiliary pump motors in stock or installed on current S-IB stages to determine the type of thermal switch installed. Inspection of each of the S-IB-5 auxiliary pump motors was conducted during in-house storage (refer to paragraph 4.2.2.12).

Reference: PAN 16 and paragraph 4.3.2.21 in S-IB-7 Assembly and Test Report, RB-B7-EIR-5.1

### 2.3.4 LOX TURBOPUMP TEMPERATURE PROBE INSPECTION

Due to discovery of a misconnection between a lox turbopump temperature probe and a zone box on stage S-IB-3 at KSC, a special inspection was conducted on the lox turbopump temperature measurements (C1-1 through C1-8) of stage S-IB-5 during storage. Inspection verified proper connection of the aforementioned measurements. Effective on S-IB-7 and subsequent stages, special instructions have been incorporated into functional checkout procedures to provide assurance for connecting the temperature probes to the proper zone box and verification that the helicon leads for the lox turbopumps are properly identified (AIECR P-2316 and AIECR P-2317).
Reference: UCR KSC 050140 and UCR KSC 050082

### 2.3.5 SERVO ACCELEROMETER UNIT INSPECTION

During storage, the measurement components for measurements A7-12, A53-11, and A54-11 were removed from the stage for special inspection of the diodes in the servo accelerometer units. This was accomplished to identify and subsequently replace obsolete Motorola 1N965B diodes on the internal PWAs. The subject diodes have a history of failure or intermittent operation when subjected to vibrations or shock testing in accordance with MIL-Standard-750. As a result of the inspection, diode CR4 was replaced in servo accelerometer units 50C10286, serial numbers SA0689 (measurement A53-11) and SA0688 (measurement A54-11). The 50C10384 servo accelerometer unit for measurement A7-12 contained the correct diodes. Subsequent to rework, the three measurements were recalibrated and the servo accelerometer units were reinstalled. The accelerometers were left off the stage to prevent redundant removal during post storage reverification checkout after which they were installed.
Reference: PAN 20

## 2.3.6 LIQUID LEVEL RACK INSPECTION

2.3.6.1 During modification and refurbishment, the two 60C50120 liquid level racks, serial numbers 508015 for measurement L20-F1 and 508016 for measurement L20-F3, were removed from the stage to facilitate visual inspection of internal PWAs. The liquid level racks met all specifications and were subsequently retested to QCI 61991 and reinstalled.

2.3.6.2 The aforementioned special inspection was prompted by findings following return of a similar liquid level rack from stage S-IB-4 at KSC. Four liquid level rack PWAs (amplifier card GV-105-B1) were found to have green deposits on the leads of a 100-microfarad capacitor which had caused pitting of the leads. The subject PWAs were returned to the vendor who established the green deposits to be nickel chloride and nickel hydroxide. These chemicals resulted from a galvanic reaction between the capacitor metals when electrolyte leaked from the capacitors during the extended period of stage exposure. The problem was compounded by component age and heat from surrounding resistors.

2.3.6.3 Further inspection of liquid level racks is to be accomplished by Systems Launch Branch as close to launch as possible without imposing schedule complications for stages S-IB-5 and S-IB-6. No additional corrective action is contemplated as the subject capacitors are not used on stages subsequent to S-IB-6.

Reference: UCR KSC 050979, FFADS 1131, FFADS 1879, and UCR Follow Up 51000

## 2.3.7 "B" NUT INSPECTION

During the modification and refurbishment period, a special inspection was conducted of all MC124D8UW "B" nuts on stage S-IB-5. A Nortek NOT-3 eddy-current tester was used to ascertain that the subject nuts were of proper alloy and had been heat treated in accordance with specifications. Inspection of "B" nuts was conducted on all stages and all "B" nuts in stock prompted by the discovery of split "B" nuts by another user (IBM) who had a source common to CCSD. On stage

S-IB-5, one tube assembly was found to contain improperly heat treated "B" nuts and was subsequently replaced.
Reference: PAN 39, revisions A, B, and C and WAN 264, revisions A, B, C, and D

## 2.3.8 PNEUMATIC LINE INSPECTION

2.3.8.1 It was discovered during prestatic functional checkout operations of stage S-IB-12 that two pneumatic tube assemblies were cross connected on all four outboard engines. The crossed tube assemblies, 60C11939 (to TOP switch calibration port) and 60C10674 (for the lox seal cavity purge), appeared to be routed and connected correctly due to their physical appearance. Since all of the subject lines had been lox cleaned, tests indicated that the cross connections had not resulted in contamination.

2.3.8.2 As a result of these findings, a special inspection was conducted on all current S-IB stages to assure correct configuration and routing of lines. Inspection of stage S-IB-5 revealed that the questionable tube assemblies were properly connected, but they were not routed and clamped in accordance with drawing specifications.

2.3.8.3 To correct this condition on all stages, templates were fabricated to form new tube assemblies in order to change the routing and thus prevent the possibility of cross connection. Subsequently, during modification and refurbishment, the new tube assemblies and associated brackets were installed on stage S-IB-5.

## 2.3.9 ENGINE CABLE INSPECTION

During modification and refurbishment, insulation resistance inspection was conducted on those engine cables manufactured with wire using asbestos and teflon as an insulation material. Past history has indicated a tendency of this type cable to decrease insulation resistance with the passage of time. Outboard engine cables 1W5, 1W8, 2W5, 2W8, 3W5, 3W8, 4W5, and 4W8 and inboard engine cables 5W13, 6W13, 7W13, and 8W13 were checked in accordance with QCI 79540 and found to be within the specified limits.

## 2.3.10 TM PACKAGE INSPECTION

The 13A440 TM multiplexer 60C50081-19, serial number 009, the 13A484 TM multiplexer 60C50081-21, serial number 010, the 13A485 PCM/DDAS assembly 60C50079-3, serial number 001, the 13A495 TM calibrator assembly 50C12011-3, serial number 13, and the 9A700 RDSM 50C12088-3, serial number 008, were removed from stage S-IB-5 during the modification and refurbishment period to undergo special inspection for cracked solder joints (refer to paragraph 4.2.3.6). After inspection and completion of necessary rework, the assemblies were reinstalled on the stage.
Reference: WAN 165I

## 2.3.11 PCM/DDAS ASSEMBLY INSPECTION

In compliance with a request from the Materials Test Group of QC Engineering, PCM/DDAS assembly (13A485) 60C50079-3, serial number 001, was again removed for inspection just prior to post storage reverification checkout. It had been determined that the subject assembly contained one PWA that was reworked in the same time period as other boards found to have severe discoloration of "Hysol" conformal coating. It was therefore necessary to perform visual inspection to assure that this PWA had not discolored since installation (refer to paragraph 4.2.3.9.).

## 2.3.12 CABLE INSTALLATION INSPECTION

2.3.12.1 NASA conducted an audit of the cable installation on stage S-IB-4 at KSC and recorded undesirable conditions regardless of whether drawing specifications were met. Pictures of these undesirable conditions were presented to CCSD with instructions to check other current stages to assure the best possible cable routing. The inspection reports and photographs were carefully reviewed and a special instruction (QCI 75069) was prepared which included photographs taken on stage S-IB-4. The purpose of the QCI is to alert inspection personnel as to the type of undesirable conditions they should recognize during installation and subsequent inspections

on the stage. Classes were held to familiarize responsible Manufacturing and QC personnel with the requirements of the QCI.

2.3.12.2 During modification and refurbishment of stage S-IB-5, a review of cable routing was performed by CCSD QC and Manufacturing followed by a similar inspection by NASA-MAF inspectors. In total, 303 CCSD and 27 NASA squawks were written. All correctable conditions were reworked, reinspected, and accepted. The balance of the squawks (14 CCSD and 5 NASA squawks) were evaluated by CCSD Design and QC Engineering and were concluded to be acceptable and in accordance with drawing requirements.
Reference: Squawk Sheets 24034 through 24039

2.3.12.3 Subsequent to the aforementioned shakedown inspection by CCSD and NASA-MAF, an inspection team consisting of R-QUAL (NASA-MSFC) personnel performed on-board inspection of cable routing on stage S-IB-5. A total of 86 undesirable conditions were recorded during the inspection. Each of the conditions were categorized into one of three criticality classifications, defined as follows:

a. Critical, a condition that would not sustain the cable function. Two items were so classified.

b. Major, a condition that may not sustain the cable function. Sixty-seven items were so classified.

c. Minor, a condition that would sustain the cable function. Seventeen items were so classified.

2.3.12.4 CCSD personnel from QC, Design, and Manufacturing Engineering along with Manufacturing and Inspection departments reviewed the 86 undesirable conditions and agreed upon actions to be taken by CCSD. A meeting was then held with representatives present from the cognizant CCSD and NASA operations to review the recorded conditions. It was stipulated that this special inspection was intended to be a "fresh eyes" approach that was being conducted at all prime NASA contractors. Many of the items cited were acknowledged to be outside the scope of CCSD-released engineering drawing requirements. Nevertheless, each condition listed was discussed and CCSD

recommended dispositions established. In compliance with NASA request, CCSD provided a resume of recommended dispositions for each condition listed in the form of contractual correspondence. Corrective measures were taken as listed in the following sub-paragraphs.

2.3.12.5 A group of 34 undesirable conditions were reworked by CCSD and accepted by CCSD and NASA-MAF inspection. Correction of these conditions consisted of adding spot ties or clamps to provide additional support for cables and cable trunks, additions of felt and tape for increased cable protection, minor cable rerouting, and replacement of clamps. The two critical conditions were included in this group.

2.3.12.6 For the correction of 13 undesirable conditions consisting of engine cables that had excessive length or were clamped to tube assemblies, and 2 conditions involving undesirable shielding termination, CCSD initiated ECPs ET-12010 and ET-40717. Both ECPs were rejected and no further action is pending; therefore, the conditions are considered acceptable.

2.3.12.7 ECP ET-12012 was submitted, prompted by 6 undesirable cable support conditions located at the firewall cable connector mounting plates and the two propulsion distributors. This ECP has been approved to incorporate cable support brackets on S-IB-8 and subsequent stages, and has been resubmitted for approval to expand the effectivity for stages S-IB-5 through S-IB-7.

2.3.12.8 The R-QUAL inspection cited the fact that the electrical connector keyways at the lower umbilical plates were not all oriented in the aft direction and recorded this as 1 undesirable condition. To incorporate uniform connector orientation, ECP ET-12025R1 was initiated and approved for S-IB-6 and subsequent stages. Revision 2 of the ECP is pending approval for stage S-IB-5.

2.3.12.9 No action will be taken for stage S-IB-5 regarding 1 undesirable condition, the absence of protective covers around the ventilating holes of the auxiliary pump motors. Nevertheless, protective covers were authorized for S-IB-7 and subsequent stages by approval of ECP ET-21145.

2.3.12.10 A use-as-is disposition was given for 12 items which consisted of cables supported by tube assemblies. ECP ET-12026R1 was submitted for approval recommending changes which would correct similar conditions on S-IB-8 and subsequent stages. Approval was not received; however, CCSD Engineering will revise and resubmit the ECP.

2.3.12.11 To correct 3 items regarding improper capping of connectors, CCSD initiated ECP ET-40732 directing addition of metal protective caps on all unused connectors with "live" circuits to prevent possible shorting or damage. NASA rejected ECP ET-40732 and directed that it be revised to include all unused connectors and then be resubmitted. This had not been accomplished at time of writing, though proposed effectivity is S-IB-5 and subsequent stages.

2.3.12.12 No CCSD action was taken on 10 of the undesirable conditions. The R-QUAL inspection team had recommended that 9 be used as is and CCSD concurred with the disposition. These 9 were opinion-type squawks involving the length of the service loop leading to connectors. One other item involving identification of Rocketdyne cables will have to be assigned to Rocketdyne by NASA for their action.

2.3.12.13 The R-QUAL inspection team had recommended that the four remaining conditions be reworked; however, CCSD did not concur defining the respective reasons in the resume which was presented to NASA. The four items involved plastic dust caps on distributors, cables with insufficient support and excessive length, and improper breakouts of coaxial cables. Informally, R-QUAL had indicated that they would like to have three of the four items resolved if possible. Therefore, the actual conditions were reviewed on the stage by CCSD with a representative from I-MICH-Q and a mutual agreement was reached. Spot ties were added and felt removed to remedy two of the conditions and one was considered acceptable.

## 2.3.13 DISTRIBUTOR SPECIAL INSPECTIONS

### 2.3.13.1 RW59VR5 Resistors.

2.3.13.1.1 Action taken as a part of the Systems Safety Program and the CCSD Quality Improvement Program disclosed that procurement procedures did not specify source control for RW59V7R5 resistors (7.5 ohms, 3 watts) which are used in the 9A1 and 9A2 propulsion distributor assemblies. It was the intent of CCSD Engineering for them to be procured from a "sole source", Ohmite Manufacturing Company. The specific resistor should be Ohmite part number 991-3 which has 1000-volt insulation, molded of vitreous enamel, and exceeds the requirement of Specification MIL-R-26C. Other Ohmite RW59V7R5 axial lead resistors with dipped insulation are available, but should not be procured.

2.3.13.1.2 Since source control requirements were insufficient to implement the "sole source" procurement, CCSD obtained these resistors from six different wholesalers, five of which supplied the proper Ohmite resistors and one of which supplied Tru-Ohm resistors manufactured by Memcor Company. Both are manufactured to the requirements of Specification MIL-R-26C.

NOTE

Tru-Ohm was the brand name used by Memcor Company for the procurement made in 1965. Since that time, the company has changed ownership and those resistors purchased and tested in 1967 carry the Memcor name. The electrical requirements of these resistors are identical and in accordance with Specification MIL-R-26C.

2.3.13.1.3 In order to determine the effect of using the Tru-Ohm (Memcor) resistors in the propulsion distributors, CCSD Engineering performed tests using both Ohmite and Memcor resistors. It was found that when three adjacent Memcor resistors were shorted directly to ground, sufficient heat would be generated to ignite the outer jacket of the resistors. Two

similar tests with two adjacent resistors did not result in flame. Simultaneous tests with Ohmite resistors were conducted to observe the effects. None of the Ohmite resistors burst into flame. Furthermore, design specifications state that this type resistor must act as a fuse when a specific overload is encountered to provide a safe method to open the circuit. Only Ohmite resistors were qualified to perform this function by the engineering tests.

2.3.13.1.4 Subsequent to the tests, CCSD issued PAN 47 to purge all Tru-Ohm RW59V7R5 resistors either in stock at MAF or installed on stages S-IB-5 through S-IB-12. In the propulsion distributors, RW59V7R5 resistors are used in each of the conax valve squib circuits, the premature ignition sensing circuits, and the conax valve position indication circuit. This requires a total of eighteen resistors per stage.

2.3.13.1.5 During post storage reverification checkout of stage S-IB-5, propulsion distributor assembly (9A1) 60C41054, serial number SA0658, and propulsion distributor assembly (9A2) 60C41066, serial number SA0651, were removed for special inspection in accordance with WAN 276. All RW59V7R5 resistors in the 9A2 distributor were Ohmite part number 991-3 and therefore were acceptable. In the 9A1 distributor, one Tru-Ohm resistor was found which was replaced by a 991-3 Ohmite resistor. After rework of 9A1 distributor serial number SA0658, an acceptable electrical test was conducted using the DITMCO 610 Automatic Circuit Analyzer. Subsequent to inspection and test, the propulsion distributor assemblies were reinstalled on the stage. Retest of related systems was accomplished during post storage reverification checkout.

2.3.13.1.6 Final corrective action has been established in the form of ECP ET-40737 which incorporates source control drawing 60C00530 to define engineering requirements for procurement of these specific resistors and acceptance activities for S-IB-5 and subsequent stages.

2.3.13.2 1N540 Diodes.

2.3.13.2.1 While inspecting the propulsion distributors from stages S-IB-7 and S-IB-9 in compliance with PAN 47, it was noted that two different types of 1N540 diodes were installed.

Both JAN 1N540 diodes and several S1N540 screen diodes were identified to be in the distributors, and some diodes, due to their installed position, were unidentifiable. It was the intent of CCSD Engineering to "sole source" JAN 1N540 diodes, manufactured by General Instruments Co., for this diode application in the distributors of stages S-IB-5 through S-IB-9. However, as in the case with the RW59VR5 resistors, there was insufficient source control documentation to implement "sole source" procurement.

2.3.13.2.2 The S1N540 diodes are preferred equivalent diodes as specified by drawing 60C00233 and are the required diode for use on S-IB-10 and subsequent stages. Due to the mixture of diodes in the distributors and the fact that some could not be identified, PAN 51 was issued directing removal of the main distributor and propulsion distributors from stage S-IB-5 to facilitate special inspection for diode identification.

2.3.13.2.3 CCSD Engineering evaluation of diode application was conducted subsequent to the aforementioned discovery. As a result of this evaluation, ECP ET-40741 was initiated and approved authorizing use of S1N540 diodes for replacement as necessary, effective for stages S-IB-5 through S-IB-9. Another reason for this action was that the stock of JAN 1N540 diodes is depleted and none have been reordered.

2.3.13.2.4 During post storage reverification checkout, main distributor assembly (12A1) 60C40190, serial number SA0617, and propulsion distributor assemblies serial numbers SA0658 (9A1) and SA0651 (9A2) were removed from the stage for inspection to PAN 51. Inspection consisted of a check for identification of 1N540 diodes and subsequent removal of those that could not be clearly identified as either JAN 1N540 General Instruments diodes or S1N540 diodes. Unidentifiable diodes removed and replaced by S1N540 diodes were as follows:

a. The 12A1 main distributor assembly contains 40 of the subject diodes. 5 were unidentifiable, therefore were replaced and scrapped. Reference: Squawk 26037

b. The 9A1 propulsion distributor assembly contains 23 of the subject diodes. 15 were unidentifiable, therefore were replaced and scrapped.
Reference: Squawk 26036

c. The 9A2 propulsion distributor assembly contains 16 of the subject diodes. 7 were unidentifiable, therefore were replaced and scrapped.
Reference: Squawks 26035 and 26038

2.3.13.2.5 The unidentifiable diodes that were removed from the distributors of stage S-IB-5 were identified upon removal to be either JAN 1N540 manufactured by General Instruments or S1N540 diodes. Subsequent to inspection and rework, the three distributors were reinstalled on stage S-IB-5 prior to completion of post storage reverification checkout. Corrective action, with immediate effectivity, was to include a general instruction note in applicable documentation to the effect that assembly components are to be oriented to permit proper identification after assembly. However, this change does not permit re-orientation where it would conflict with design requirements.

# SECTION III

# POST STORAGE REVERIFICATION CHECKOUT

## 3.1 SCOPE

3.1.1 This section covers post storage reverification checkout of the systems and subsystems of stage S-IB-5. During functional checkout operations, actual conditions that will occur during launch are duplicated where possible and simulated when conditions prevent duplication. In addition to functionally testing mechanical and electrical components and assemblies by operating stage systems and subsystems, leak checks and hardware inspections are performed to assure that recorded test results provide an accurate measure of performance. The objectives of functional checkout operations are implemented by conducting tests in compliance with Final Acceptance Test Procedures. The procedures to be accomplished for each test are outlined in the S-IB Stage End-Item Test Plan which is issued for each functional checkout operation, e.g. post storage reverification checkout of stage S-IB-5. All test procedures that were required for post storage reverification checkout were successfully conducted for stage S-IB-5.

3.1.2 Failures that occurred and discrepancies that were found during performance of post storage reverification checkout are documented in Section IV.

## 3.2 CHECKOUT TEST RECORD

Table 3-1 lists all post storage reverification checkout procedures that were run and successfully completed. The Refer-to-Paragraph column of table 3-1 contains reference to paragraphs concerning failures and discrepancies that were found during performance of the specific procedure.

Table 3-1. Post Storage Reverification Checkout Test Record

| Procedure Name | Procedure Number | Date Completed | Refer to Paragraph |
|---|---|---|---|
| Power Distribution | 1-CM-IB-205F-A2.0 (Revision A) | 5 Jan 68 | |
| Power Up | 1-CM-IB-205F-A2.1 (Revision A) | 4 Jan 68 | |
| Power Down | 1-CM-IB-205F-A2.2 (Revision A) | 5 Jan 68 | |
| Power Up (DDAS) | 1-CM-IB-205F-A2.3 (Revision A) | 8 Jan 68 | |
| General Networks Malfunction Cutoff Test 1 | 1-CM-IB-205F-A5.0 (Revision A) | 7 Feb 68 | 4.3.3.9<br>4.3.3.12 |
| Components Test | 1-CM-IB-205F-A6.0 (No Revision) | 6 Feb 68 | 4.3.2.1 |
| General Networks Malfunction Cutoff Test 2 | 1-CM-IB-205F-A21.0 (No Revision) | 7 Feb 68 | |

Table 3-1. Post Storage Reverification Checkout Test Record

| Procedure Name | Procedure Number | Date Completed | Refer to Paragraph |
|---|---|---|---|
| Vehicle Instrumentation Program: UMA Scan and Calibrate Test With Automatic Equipment | 2-CM-IB-205F-A3.0 (No Revision) | 9 Feb 68 | 4.3.3.1 |
| Acceleration | 2-CM-IB-205F-3.1 (No Revision) | 17 Jan 68 | |
| Temperature | 2-CM-IB-205F-3.3 (Revision A) | 9 Feb 68 | 4.3.3.6 |
| Pressure Measurements | 2-CM-IB-205F-3.4 (Revision A) | 22 Feb 68 | 4.3.3.2<br>4.3.3.4<br>4.3.3.5 |
| Vibration | 2-CM-IB-205F-3.5 (No Revision) | 17 Jan 68 | |
| "K" Measurements, Signals | 2-CM-IB-205F-3.10 (Revision A) | 25 Jan 68 | |
| Liquid Level | 2-CM-IB-205F-3.11 (No Revision) | 9 Jan 68 | |
| "M" Measurements, Voltage and Current | 2-CM-IB-205F-3.12 (No Revision) | 27 Jan 68 | |

Table 3-1. Post Storage Reverification Checkout Test Record

| Procedure Name | Procedure Number | Date Completed | Refer to Paragraph |
|---|---|---|---|
| Angular Velocity | 2-CM-IB-205F-3.14 (No Revision) | 25 Jan 68 | |
| Strain | 2-CM-IB-205F-3.15 (Revision A) | 14 Jan 68 | |
| Propulsion-Turbine RPM | 2-CM-IB-205F-3.16 | 23 Jan 68 | |
| Dynamic Pressure Test | 2-CM-IB-205F-3.19 (No Revision) | 22 Feb 68 | 4.3.3.3<br>4.3.3.7 |
| Test Requirements for Pressure Measurements | 2-CM-IB-205F-19.0 (Revision A) | 4 Mar 68 | |
| Instrumentation Compatibility Telemeter vs Hardwire/Telemeter vs Predicted | 3-CM-IB-205F-A10.0 (Revision A) | 8 Feb 68 | |
| Telemeter Calibrator Test | 3-CM-IB-205F-24.1 (No Revision) | 8 Jan 68 | |

Table 3-1. Post Storage Reverification Checkout Test Record

| Procedure Name | Procedure Number | Date Completed | Refer to Paragraph |
|---|---|---|---|
| Subcarrier Oscillator Adjustment | 3-CM-IB-205F-24.2 (No Revision) | 19 Jan 68 | |
| TM Ground Station and Airborne Pre-emphasis Procedure | 3-CM-IB-205F-24.3 (No Revision) | 23 Jan 68 | |
| RF Compatibility Check | 3-CM-IB-205F-24.6 (No Revision) | 27 Jan 68 | |
| DDAS Functional Check | 3-CM-IB-205F-24.7 (No Revision) | 5 Feb 68 | |
| DDAS Calibration Verification Test | 3-CM-IB-205F-A24.8 (No Revision) | 6 Feb 68 | |
| Discriminator Adjustment | 3-CM-IB-205F-24.9 (No Revision) | 8 Jan 68 | |
| Antenna Systems Test: Range Safety Command Antenna, Lines, and Power Dividers | 4-CM-IB-205F-1.1 (No Revision) | 4 Jan 68 | |

Table 3-1. Post Storage Reverification Checkout Test Record

| Procedure Name | Procedure Number | Date Completed | Refer to Paragraph |
|---|---|---|---|
| Antenna Systems Test: TM Antenna, Lines, and Power Dividers | 4-CM-IB-205F-1.2 (No Revision) | 3 Jan 68 | |
| Antenna Systems Test: ODOP Antennas and Transmission Lines | 4-CM-IB-205F-1.3 (No Revision) | 3 Jan 68 | |
| Antenna Transmission Line Phasing | 4-CM-IB-205F-1.4 (No Revision) | 3 Jan 68 | |
| RF Systems Test: Secure Range Safety Command | 4-CM-IB-205F-7.1 (Revision A) | 19 Jan 68 | |
| RF Systems Test: TM System Checkout | 4-CM-IB-205F-7.2 (Revision A) | 18 Jan 68 | 4.3.3.10 |
| ODOP System | 4-CM-IB-205F-7.4 (No Revision) | 12 Jan 68 | |

Table 3-1. Post Storage Reverification Checkout Test Record

| Procedure Name | Procedure Number | Date Completed | Refer to Paragraph |
|---|---|---|---|
| Radiated Compatibility Interference Test | 4-CM-IB-205F-8.1 (No Revision) | 27 Jan 68 | |
| Control System | 5-CM-IB-205F-9.0 (Revision A) | 6 Mar 68 | 4.3.3.8 |
| Actuator Linearity Test With Automatic Equipment | 5-CM-IB-205F-A9.4 (Revision A) | 25 Jan 68 | |
| All Engine Gimbal Test With Automatic Equipment | 5-CM-IB-205F-A9.6 (No Revision) | 25 Jan 68 | |
| Pressure Switches | 6-CM-IB-205F-4.1 (Revision A) | 12 Jan 68 | |
| Thrust OK Pressure Switch Test With Automatic Equipment | 6-CM-IB-205F-A4.1 (No Revision) | 12 Jan 68 | |
| $GN_2$ Control Pressure System | 6-CM-IB-205F-4.2 (Revision A) | 16 Jan 68 | |

Table 3-1. Post Storage Reverification Checkout Test Record

| Procedure Name | Procedure Number | Date Completed | Refer to Paragraph |
|---|---|---|---|
| H-1 Engine Systems | 6-CM-IB-205F-4.3 (Revision A) | 15 Jan 68 | |
| Fuel System | 6-CM-IB-205F-4.4 (Revision A) | 31 Jan 68 | 4.3.2.3<br>4.3.4.1 |
| Lox Tanks Pressurizing System | 6-CM-IB-205F-4.6 (Revision A) | 19 Jan 68 | |
| Lox System | 6-CM-IB-205F-4.7 (Revision B) | 1 Feb 68 | |
| AC Heater System Test With Automatic Equipment | 6-CM-IB-205F-A4.8 (No Revision) | 16 Jan 68 | |
| Lox Seal Cavity | 6-CM-IB-205F-4.9 (No Revision) | 7 Mar 68 | |
| Pneumatic Procedures for Electrical System Test | 6-CM-IB-205F-14.0 (Revision A) | 7 Mar 68 | |
| Simulated Plug Drop | 7-CM-IB-205F-A11.0 (No Revision) | 22 Feb 68 | |

Table 3-1. Post Storage Reverification Checkout Test Record

| Procedure Name | Procedure Number | Date Completed | Refer to Paragraph |
|---|---|---|---|
| Simulated Flight Test | 7-CM-IB-205F-A20.0 (Revision A) | 4 Mar 68 | |

# SECTION IV

# SIGNIFICANT FAILURES AND DISCREPANCIES

## 4.1 SCOPE

This section presents information describing significant nonconformances encountered on stage S-IB-5 during the period beginning with movement to in-house storage and ending with shipment to KSC. Descriptions of failures that occurred and discrepancies found are grouped under headings 4.2, covering in-house storage, modification and refurbishment, and preparation for shipment, and 4.3 covering post storage reverification checkout. The descriptive paragraphs are in part number order under subheadings dividing the four primary stage systems; electrical systems, mechanical systems, instrumentation and TM systems, and structures. These system categories correspond to the primary divisions of the engineering departments of CCSD and MSFC.

## 4.2 IN-HOUSE STORAGE, MODIFICATION AND REFURBISHMENT, AND PREPARATION FOR SHIPMENT

The significant failures and discrepancies described under heading 4.2 either occurred or were discovered by means of inspection during in-house storage, modification and refurbishment, or preparation for shipment of stage S-IB-5. Where modifications or special inspections were involved, it is so stipulated and/or reference is made to a related paragraph in Section II of this supplement. In instances where system components were removed from the stage and repaired or reworked, component level retest was accomplished prior to reinstallation. Systems which incurred any form of rework, removals, or replacements prior to post storage reverification checkout were verified and accepted during functional checkout. Corrective actions requiring system retest at KSC are listed in table 5-6 and the requirement is stipulated in the applicable narrative paragraph.

## 4.2.1 ELECTRICAL SYSTEMS

Significant failures and discrepancies recorded on electrical components and assemblies are described in the following paragraphs.

4.2.1.1 Cable Assemblies 1W1 and 1W6. Inspection of engine cables during modification and refurbishment revealed what appeared to be tarnishing or deplating on pins of cable connectors 1W1J1 and 1W6J1. Rocketdyne failure analysis of a similar previous discrepancy determined the discoloration to be silver sulfide which is a good conductor and will not impair the performance of the pin. The silver sulfide deposits result due to the porous gold plating on the pins which permits formation of a sulfide on the silver undercoat. The cable assemblies were removed and the connectors cleaned by Rocketdyne using a solution of sodium cyanide and water. The pins were then rinsed with a cotton swab saturated with water and blown dry. Subsequent to Rocketdyne rework, the cables were reinstalled and CCSD performed acceptable electrical checks.
Reference: DMN M18377, DMN M18378, and Rocketdyne Failure Analysis Report F004127

4.2.1.2 Cable Assembly 1W5. During modification and refurbishment, inspection revealed a damaged protective jacket on cable branch 1W5P3 near the connector. Damage had been incurred by personnel working in the boattail area. Cable 1W5 is an engine cable (GFP), Rocketdyne part number 502235-21, and was replaced in its entirety by Rocketdyne with CCSD and NASA surveillance. CCSD performed continuity check on the new cable assembly (1W5), and prior to reconnection, insulation resistance checks were performed on all engine-1 electrical harnesses. Results were acceptable.
Reference: DMN M18257

4.2.1.3 Cable Assemblies 9W23 and 9W146. During preparation for shipment, insert damage was found in cable connectors 9W23P4 and 9W146P7. In connector 9W23P4, the insert was punctured adjacent to pin "E", and in 9W146P7, damage was located in the areas of pins "G" and "H". The mating receptacles were not damaged in either case. In compliance with MRB repair instructions, connectors 9W23P4 and 9W146P7

were cut off directly behind the potting and replaced. Potting and electrical tests were accomplished without removing the harnesses from the stage and the respective cable branches were allowed to break out at an alternate point. Verification tests will be accomplished on associated systems during normal prelaunch operations at KSC.
Reference: DMN M18800 and DMN M18798

4.2.1.4 Cable Assembly 9W39. During modification and refurbishment, inspection revealed damaged insulation near cable connector 9W39P6. The nylon jacket was split on two wires leading into the potting of the connector. In compliance with Standard Repair 009, the connector was cut off directly behind the damaged area and a new connector installed. On-stage potting was accomplished, preceded and followed by acceptable continuity and insulation resistance checks.
Reference: Squawk 23114, item 109

4.2.1.5 Cable Assembly 9W95. While preparing stage S-IB-5 for shipment to KSC, insulation damage was noted on cable assembly 9W95. The nylon jacket was scuffed 0.188 inch on one wire approximately 6 inches from cable connector 9W95P5. On two other wires, the nylon jacket and PVC were cut approximately 12 inches from the same connector. Examination of the cable bundle disclosed that the cable branch leading to connector 9W95P5 was sufficiently long to allow it to be cut back beyond the damaged area. Therefore, the cable branch was cut back to within 0.250 inch of the damage after which a new connector was installed. Repair, potting, and acceptable electrical tests were accomplished on the stage. Verification tests on associated systems will be accomplished during normal prelaunch operations at KSC.
Reference: DMN M18975

4.2.1.6 Cable Assembly 9W106. During preparation for shipment shakedown, severe insulation damage was noted on two wires of cable assembly 9W106 below the aft sump of the 105-inch lox container assembly. Bare conductor was exposed; therefore, MRB rejected the entire cable assembly. A new 9W106 cable assembly was then installed, laced into the trunk, and electrically tested with acceptable results. Related systems are to be verified during normal prelaunch test operations at KSC.
Reference: DMN M18793

4.2.1.7 Cable Assembly 11W2 .

4.2.1.7.1 While performing a routine inspection during storage, it was discovered that cable connector 11W2P4, a two-socket Cannon connector, had an insert crack extending between the sockets. Repair consisted of replacing the connector. Continuity and insulation resistance checks were performed before and after potting and all values were acceptable.

4.2.1.7.2 The cause, established from investigating past defects, was attributed to the composition of the connector insert material. This type defect has been a prevailing problem on Cannon Electric socket-type connectors supplied to CCSD at MAF. Lack of insert material integrity, as pointed out by the vendor, may have been due to the application of excessive mold release compound during the insert molding operation.

4.2.1.7.3 A joint inspection by CCSD QC and Design Engineering was performed on a sample quantity (sixty-five) of the subject type connectors in stock at MAF. The results of inspection indicated a high incidence of cracked resilient inserts (81 percent). Inspection of four new Cannon connectors, submitted to CCSD during a meeting with the vendor, disclosed that three of the four did have cracks although the cracks did not extend as far as those in the connectors drawn from stock. These cracks were located in the inner surface of the cylindrical holes molded into the parts to permit insertion of the electrical contacts. Since the condition was not corrected, Cannon Electric was removed as a supplier for socket-type connectors, shell sizes 12 and above. ECP ET-70669 was then issued directing that all of the subject connectors in stock be scrapped and future procurement will be from Bendix Corporation. The Cannon connectors on completed assemblies have been inspected for cracked inserts and defective connectors replaced.
Reference: DMN M16289

4.2.1.8 Cable Assembly 11W2. During shakedown inspection prior to post storage reverification checkout, insulation damage was found on one conductor near cable connector 11W2P4. The nylon jacket was torn approximately 0.75 inch and the wire was severely bent and separated from the potting. Repair was accomplished on the stage in compliance with Standard Repair 009. Accordingly, connector 11W2P4 was cut off behind the

the point of damage and a new connector installed. Continuity and insulation resistance checks were performed prior to and after potting; all values were acceptable.
Reference: Squawk 24248, items 8 and 9

4.2.1.9 Cable Assemblies 11W38 and 11W39. During storage, inspection revealed that coaxial cable connectors 11W38P1 and 11W39P1 had damaged lockwire holes. The holes were completely broken out through the connectors as a result of personnel improperly removing the lockwire. This has been a recurrent problem as lockwired coaxial connectors are very susceptible to damage. Repair consisted of removing rough edges from the damaged holes and drilling three new holes approximately centered between the existing holes. The connectors were then lockwired utilizing the new holes. Corrective action was issuance of Standard Repair 011 directing that coaxial connectors with broken lockwire holes be repaired in this manner.
Reference: DMN M16292

4.2.1.10 Thermal Probes (Engine 2). During modification and refurbishment, inspection revealed insulation damage on the cables of the two 20C30160 thermal probes, serial numbers 6-2-1 and 6-2-2, in the engine-2 engine compartment preignition heating thermal probe assembly 60C20889. On each probe, the insulation had separated from the electrical receptacle (2A22J1 and 2A23J1) exposing damaged shielding, and from the probe coils, exposing individually insulated wires. Previous thermal probe cable damage had been recorded prior to storage and was repaired by wrapping the cables with Scotch electrical tape; however, this was not a satisfactory repair. The damaged thermal probes were removed and replaced by two unserialized probes and subsequently scrapped.
Reference: DMN M18013 and DMN M14709

4.2.1.11 FABU Heater Blanket (Engine 4). While inspecting the stage during storage, insulation damage was noted on one lead at the potted electrical connection, an integral part of engine-4 FABU heater blanket NA5-27187-2B, serial number 155. The insulation was damaged to such an extent that bare conductor was exposed. An investigation by Rocketdyne has attributed the cause of this and other recent similar damage to repetitive inspection of the heater blanket connection. In the process of inspection, personnel twisted and turned the subject

connection in order to determine if damage existed. The design of the connector, combined with the frequency of this type inspection, will eventually introduce damage. The subject damaged heater blanket was replaced by serial number 152; however, two steps have been taken by Rocketdyne to rectify the problem and provide acceptable repair in the future. A recommendation was made to the manufacturer of the FABU heater blanket to alter the configuration of the connection, whereupon it would taper and mold into the leads rather than stop abruptly at the point where the leads enter the blanket. This would provide a more flexible connection and reduce susceptibility to damage. In the future, damage of this nature will be repaired rather than the blanket replaced. This will be accomplished in compliance with a revision to Rocketdyne H-1 Engine Maintenance and Repair Manual R-3620-3.
Reference: DMN M16576

4.2.1.12 TOP Switch (Engine 6).

4.2.1.12.1 Inspection during modification and refurbishment disclosed a damaged electrical receptacle on the engine-6 forward TOP switch NA5-27446, serial number 25503. The cause was attributed to personnel working in the engine area. The mating cables, when connected to the switches, form "stirrup-like" loops which are extremely vulnerable to foot damage. In addition to the switch damage, it was found that cable branch 6W12P2 to the inboard TOP switch and cable branch 6W15P2 to the forward TOP switch had been cross connected.

4.2.1.12.2 A check of stage history showed that the TOP switches had been removed during static test operations to undergo radiographic inspection. The cross connection was made when the TOP switches were reinstalled. Also at this time, the cable clamp and spacer had been omitted from the 6W12P2 cable installation on the engine A-frame. No short signs were provided on the TOP switch panel assembly which contributed to the conditions that resulted in cross connection; however, in order to make connection, the two cable connectors had to be rotated 180 degrees. This caused an obvious twist in each cable branch.

4.2.1.12.3 Rocketdyne replaced TOP switch NA5-27446, serial number 25503, on engine 6, installing an NA5-27445 TOP switch, serial number 25792A (NA5-27445 switches are approved production replacements for obsolete retrofit NA5-27446 switches). The proper cable clamp and spacer were installed and the cable branches connected to the specified TOP switches.

4.2.1.12.4 To provide corrective action, manufacturing and inspection personnel at MSFC and MAF have been cautioned to exercise extreme CARE during entry and performance of work assignments on board the stage. Also, CCSD personnel at MSFC were informed of the cross connection and were alerted to assure that when cables are reconnected, the task is performed in compliance with applicable CCSD and Rocketdyne specifications.

4.2.1.12.5 It should be noted that the crossed TOP switch cables were not detected during poststatic functional checkout operations as the cables have the same function and the three switches are tested simultaneously for each engine. Protective covers were installed to protect the TOP switches and hypergol igniter monitor switches during post storage reverification checkout (refer to paragraph 2.2.29).
Reference: DMN M18010

4.2.1.13 <u>TOP Switches (Engines 2, 3, and 4)</u>.

4.2.1.13.1 During modification and refurbishment, engine area inspection found damaged receptacles on the forward NA5-27446 TOP switches on engines 2, 3, and 4. Personnel working in the engine area had inadvertently bent the base of each receptacle due to protective covers not being installed. Subsequently, the damaged TOP switches, serial numbers 25357 (engine 2), 25354 (engine 3), and 25513 (engine 4), were replaced by new configuration NA5-27456 TOP switches serial numbers 25985A, 25923A, and 25986A, respectively. The new configuration switches have a reinforced case and are interchangeable with both NA5-27446 and NA5-27445 TOP switches.
Reference: DMN M18388, DMN M18389, and DMN M18390

4.2.1.13.2 Originally, protective covers for the TOP switches and hypergol igniter monitor switches were to be installed on S-IB_6 and subsequent stages since S-IB-5 had completed assembly and test and was, at the time, in storage. Due to the extensive additional operations that were necessary, subsequent to storage, on stage S-IB-5, protective covers were fabricated and installed during post storage reverification checkout (refer to paragraph 2.2.29).

## 4.2.2 MECHANICAL SYSTEMS

Significant failures and discrepancies recorded on mechanical components and assemblies are described in the following paragraphs.

4.2.2.1 Fuel Wraparound Lines. The intent of this paragraph is to provide final closeout action to the fuel wraparound line noise problem documented in paragraph 6.6.2.1 of the basic publication, Assembly and Test Report, S-IB-5, RB-B5-EIR-5.1. Paragraph 6.6.2.1.4 should be amended to read: Based on the investigations conducted by CCSD Design and QC Engineering, the CCSD Systems Test Department has concurred that the fuel wraparound line noise can be considered normal. It is not necessary to further evaluate the condition during prelaunch operations at KSC.

4.2.2.2 Sphere Fill and Vent Valve. Early in the modification and refurbishment period, the 60C20458 $GN_2$ control pressure system assembly, serial number 0004, was removed for refurbishment of expired elastomers (refer to paragraph 2.2.18). During the subsequent rework in the "clean room", several nicks and gouges, ranging from 0.002 to 0.005 inch in depth, were discovered around the ports of the associated sphere fill and vent valve 20C30131, serial number 159. Sphere fill and vent valve serial number 159 was removed from the control pressure system assembly and repaired by removing raised metal and applying alodine around the damaged areas. In order to expedite refurbishment and reinstallation of control pressure system assembly serial number 0004, a replacement sphere fill and vent valve, serial number 147, was installed. Reference: DMN M17871

4.2.2.3 QD Nipple (Lox 2). During storage, while implementing the requirements of the structural improvement in the 70-inch lox containers (refer to paragraph 2.2.7), damage was noted on the sealing surface of QD nipple 20C30133, serial number RA0714, at the position-II forward umbilical plate. Nipple serial number RA0714 was replaced on the stage by serial number RA1827 and returned to the vendor for rework. Reference: DMN M16288

4.2.2.4 Corroded Fittings and Tube Assemblies.

4.2.2.4.1 During modification and refurbishment, while removing age-controlled items (refer to paragraph 2.2.18), a form of corrosion was found on QD dust cap 20C30148, serial number RA0670, and on the associated MC200D4U elbow, taken from the position-II lower umbilical plate. At a later date, similar corrosion was exhibited in several lox sensing line components which had been removed or exposed for visual inspection due to the packing changeout modification at the position-IV umbilical (refer to paragraph 2.2.25.5). The specific contaminated components were two 20C30149 QD dust caps, serial numbers RA0674 and RA2726; lox sensing tube assemblies 60C11670 and 10C11360; QD nipples 20C30138, serial numbers RA0659 and RA0660; and two MC200D4U elbows. All the aforementioned components were cleaned and reused with the exception of the two lox sensing line elbows which were scrapped and replaced. Reference: DMN M17699, DMN M17700, DMN M17911, DMN M18267, DMN M18268, DMN M18269, and DMN M18275

4.2.2.4.2 Similar minor corrosion and/or residue was found on fittings of stages S-IB-3 and S-IB-4. Investigation has attributed a percentage of residual deposits to dried leak-detector solution used during functional checkout and static test operations. Other deposits are sodium silicate and/or aluminum oxide which forms on aluminum B-nuts lubricated with Molylube N. A constituent of Molylube N is a sodium silicate binder, alkaline and hygroscopic by nature, which will tend to corrode aluminum in the presence of moisture. Additional tests disclosed that anodizing of the B-nuts, by the manufacturer, was not a satisfactory protection in many cases.

4.2.2.4.3 CCSD Materials Engineering recommended the following procedures for removal of aluminum corrosion products or leak-detector solution residue from fasteners, tubing, and B-nuts.

a. Brush residue off area with stiff-bristled, non-metallic brush, such as nylon or tampico.

b. Wipe affected area clean of residue with a clean, lint-free cloth, moistened slightly with Freon passive cleaning agent or other approved solvent.

c. Where it is definitely established that the residue is from leak-detector solution, and provided the area being cleaned is completely accessible for absorbent drying, deionized or distilled water may be used as a cleaning agent. After complete removal of water, follow step b. above.

4.2.2.4.4 In order to provide corrective action against fitting corrosion on subsequent stages, cleaning instructions are provided in those operations which follow static firing and in-house storage, to be utilized as necessary. In addition, applicable functional acceptance test procedures have been revised to include instructions for cleaning and drying tube assemblies and fittings following application of leak-detector solution.

4.2.2.5 Lox Vent Valve Assemblies.

4.2.2.5.1 The 60C21263 gox venting assemblies were removed from container unit assemblies, lox 2, lox 3, and lox 4, to facilitate soft good replacement in the integral 20C30122 lox vent valve assemblies (refer to paragraph 2.2.25.3). After removal, the lox vent valve assemblies, serial numbers CH131, CH104, and CH113, in respective gox venting assemblies serial numbers 0017 (lox 2), C0001 (lox 3), and C0004 (lox 4), were completely disassembled revealing numerous discrepancies, primarily attributed to wear, in subassemblies and components. Vent valve serial number CH131 was reinstalled on the stage after rework along with associated venting assembly serial number 0017. Gox venting assemblies serial numbers 1382 and 1250 (with valves 863 and CH106) were installed on stage S-IB-5 as replacements for serial numbers C0001 and C0004 (with valves CH104 and CH113), respectively.

4.2.2.5.2 In lox vent valve assembly serial number CH131, eight valve components were replaced and one reworked. Seventeen subassemblies and components of valve serial number CH104 were discrepant and were subsequently reworked. In serial number CH113, ten discrepant components required rework. Damage consisted of corrosion, metal wear and tear such as gouges and scratches with raised matal, metal discolorations, and components not lubricated that required lubricant. All valve components, after having been replaced, were later reworked and reused.
Reference: DMN M17888, DMN M17893A, and DMN M17895

4.2.2.6 GG Lox Injector Purge Tube Assemblies (Engines 2, 3, 5, and 6). Prior to post storage reverification checkout, shakedown inspection discovered bent GG lox injector purge tube assemblies on engines 2, 3, 5, and 6. The bent tube assemblies (557286 on inboard engines and 557287 on outboard engines) are 0.375-inch stainless steel lines which connect from the purge panel on the forward end of the engine to a check valve on the GG. Rocketdyne replaced the damaged tube assemblies under CCSD and NASA surveillance. Damage of this nature has been recurrent and is caused by personnel connecting flex lines to the purge panel without holding the mating elbow secure when applying torque. This will cause the subject tube assembly to twist and become bent. Cautionary notes are included in functional acceptance test procedures and have also been added to process sheets instructing that special emphasis be put on holding the subject tube assembly at the elbow aft of the purge panel to prevent this type damage. It has been stressed that all personnel employ CARE and follow the cautionary notes.
Reference: DMN M18398, DMN M18399, DMN M18400, and DMN M18628

4.2.2.7 Main Pump Return Metal Hose Assembly (Engine 4). An inspection of hydraulic installations during modification and refurbishment revealed that the 60C20100 main pump return metal hose assembly on engine 4 was not routed in accordance with hydraulic installation drawing 60C20840. The subject hose assembly, one of two connecting the main hydraulic pump to the hydraulic package, was routed under instead of over the adjacent flexible hose assembly 60C20689. Using care not to contaminate the hydraulic system, the accumulator reservoir was

bled of pressure and the misrouted hose was disconnected at the main pump, routed correctly, and resecured. The hydraulic system was then reserviced by functional checkout personnel in compliance with QCI 50012, revision 5.
Reference: DMN M18395

4.2.2.8 Butterfly Gox Control Valve. Part of modification and refurbishment was removal of the 60C20129 butterfly gox control valve, serial number B432110, for replacement of soft goods (refer to paragraph 2.2.25.1). During disassembly of the valve, 20 minor discrepancies, primarily attributed to wear, were discovered in subassemblies. The discrepancies were reworked and/or repaired aside from several scored 60C21551 roller bearings which were replaced. Subsequently, after rework and soft good replacement, butterfly gox control valve serial number B432110 was reinstalled on the stage.
Reference: DMN M17894

4.2.2.9 Fuel and Lox Shutoff Valves (Prevalves, Engines 3, 5, and 7).

4.2.2.9.1 During storage, five ball-rotor valves were removed to undergo pressure test (refer to paragraph 2.2.8.1) and were subsequently reinstalled. At approximately the same time, engineering revisions were released to Bolted Joint Torque Chart 60C10837, effective for stages S-IB-4, S-IB-6, and all subsequent stages, which specified several changes in torque requirements (ECP ET-11917 and ECP ET-60446). It should be noted that the torque requirements for stage S-IB-5 were not changed by the aforementioned revisions; however, due to a misinterpretation of effectivity, the flanges of four valves were overtorqued.

4.2.2.9.2 Fuel shutoff valves 60C20340, serial numbers 154, 146, and 156 (prevalves, engines 3, 5, and 7 respectively), were torqued to 110 inch-pounds plus running torque on the inlet flange bolts, and 130 inch-pounds plus running torque on the outlet flange bolts. The torque requirements are 85 to 105 inch-pounds and 70 to 90 inch-pounds, including the running torque, at the inlet and outlet flange bolts, respectively. The engine-3 lox shutoff valve 60C20339, serial number 147, outlet flange bolts were torqued to 130 inch-pounds with specifications being 70 to 90 inch-pounds. The overtorque conditions resulted

from the utilization of ECP ET-60446, which has been cancelled, and the utilization of Bolted Joint Torque Chart 60C10837, Revision A, which is not effective for stage S-IB-5.

4.2.2.9.3 MRB dispositioned that the installations were acceptable as is; however, should a joint be broken on any of the four valves during subsequent operations, or if the compressive pressure on associated gaskets is in any way relieved, it is required that the gasket be replaced and the joint torqued to comply with the applicable revision of torque chart 60C10837. Manila tags were attached to each of the four prevalves reflecting this disposition. The tags are not to be removed unless rework is accomplished.
Reference: DMN M16593

4.2.2.10 $GN_2$ Control High Pressure Switch. During refurbishment of the 60C20458 $GN_2$ control pressure system assembly, serial number 0004 (refer to paragraph 2.2.18), oxide deposits were discovered on the connector pins of the associated 60C20452 $GN_2$ control high pressure switch, serial number 25266. The pressure switch was removed from the assembly for rework and subsequently replaced by serial number 25274. Oxidation was cleaned from the connector of serial number 25266, using a solution of ammonium hydroxide, alconox, and water. The cleaned area was then rinsed and blown dry after which the switch was returned to stock.
Reference: DMN M17877

4.2.2.11 Flexible Hose Assembly (Engine 3). During modification and refurbishment, inspection revealed a damaged 60C20688 flexible hose assembly in the engine-3 hydraulic system. The flexible hose assembly, connected to pitch servo actuator 60C60001, serial number 355, making up part of the line to the hydraulic package, had a crimped teflon liner. The line was replaced, taking extreme care to maintain system cleanliness, and subsequently scrapped. After replacement, the engine-3 hydraulic system was reserviced in compliance with QCI 50012, revision 5.
Reference: DMN M18009

4.2.2.12 Auxiliary Pump Motors (Engines 1, 2, 3, and 4). During storage, the three 60C20739 auxiliary pump motors in the hydraulic packages of engines 1, 2, and 3, and the 60C20847 auxiliary pump motor on engine 4 were radiographed (refer to paragraph 2.3.3). The radiographs revealed that each motor contained an unreliable MS1350-310-161 thermal switch, manufactured by Elmwood Sensors, Inc. Then, in compliance with PAN 16, each of the auxiliary pump motors were removed from stage S-IB-5 to undergo rework by installing a "Klixon" switch which had passed temperature acceptance test. Updated pump motors (60C20739 for engines 1, 2, and 3, and 60C20847 for engine 4) with "Klixon" switches were installed as replacements as indicated in table 4-1.
Reference: DMN M16913, DMN M16914, DMN M16915, and DMN M16916

Table 4-1. Removal and Installation of Auxiliary Pump Motors

| Engine | | Removed SN | Installed SN |
|---|---|---|---|
| Position | SN | | |
| 1 | H-7066 | 1352867 | 1297575 |
| 2 | H-7067 | 1352864 | 1297573 |
| 3 | H-7068 | 1352863 | 1297833 |
| 4 | H-7069 | 101 | 105 |

4.2.2.13 Fuel Safety Relief Valve (Fuel 3).

4.2.2.13.1 While removing fuel safety relief valve 60C21490, serial number 14, and fuel vent line 20C00051, serial number H30602, from fuel-3 container unit assembly to accomplish vent valve modification (refer to paragraph 2.2.26), the associated MC266C236 O-ring was found to be damaged. One section of the O-ring, approximately 2.25 inches in length, was missing prompting an immediate search of all fuel system components in the forward end of the stage. The fuel safety relief valve, vent line, interconnect line, and manifold were thoroughly checked and fuel-3 container unit assembly was entered and inspected without finding the missing O-ring segment. A similar problem

was encountered on stage S-IB-6, and again, the missing piece could not be found.

4.2.2.13.2 An analysis was made by CCSD Engineering to determine the effect if the missing O-ring segment remained in the system and proceeded toward the engines. The following conclusions were drawn:

a. The antivortex screen in the container sump, with a mesh of 0.034 inch, should prevent passage of the segment beyond that point.

b. Should the antivortex screen be damaged and permit the segment to pass, it would be stopped at the ejector screen, having a mesh of 0.059 inch.

c. Particles passing these screens would be small enough to pass through the engine injector plate orifices and thus, would not degrade engine performance during flight.

4.2.2.13.3 For the reasons itemized in the preceding paragraph, search was discontinued for the missing O-ring segment and the stage was considered acceptable for flight. The cause of the O-ring damage was attributed to the tight fit of the mating flanges and inability to inspect the O-ring prior to torquing the fasteners. An extended or unrestrained bellows will often allow contact between mating flanges during installation with possible damage to the O-ring and/or flange surface.

4.2.2.13.4 In order to provide corrective action, it is necessary to compress the associated bellows on the fuel vent line to reduce the longitudinal expanse of the line and leave a gap between mating flanges. With a gap, it is possible to properly position the O-ring prior to connection. A previously designed bellows retracting tool had proved unsatisfactory; therefore, a new retracting tool (AF-1-M60C11003) was designed. The use of the new retracting tool will be designated on subsequent process sheets to implement corrective action against recurrence of this type problem and to avoid scratches on mating flanges. To assure that cut O-rings are not present in stages S-IB-7 through S-IB-12, action has been taken to inspect the fuel venting system of each stage.

4.2.2.13.5 A special test was conducted by CCSD QC Engineering in order to determine the feasibility of a joint containing a damaged O-ring passing pressure acceptance test. Test results indicated that when the flanges are mated utilizing a heavily lubricated O-ring, regardless of the structural integrity of the O-ring, leakage can be prevented at the subject connection. A satisfactory seal is accomplished due to the fastener torque and the flatness and finish of the mating flanges.
Reference: DMN M18001 and FFADS 1199

4.2.2.14 Fuel Depletion Sensor (Fuel 2). Prior to installation of 60C21690 fuel depletion sensors in container unit assemblies, fuel 2 and fuel 4 (refer to paragraph 2.2.20), personnel attempted to remove the nylon sleeve from sensor serial number 570027 mistaking the sleeve for a protective cover. Contamination resulted which required the sensor (for fuel 2) to be recleaned and retested before installation. Manufacturing and QC personnel have been instructed not to attempt to remove any item from a critical component, under any circumstances, without first consulting applicable drawings and EOs or contacting supervision.
Reference: DMN M18015

4.2.2.15 Lox Seal Cavity Drain Unions (Engines 4 and 7). During inspection following implementation of Rocketdyne Engine Field Inspection Request H1-19A (refer to paragraph 2.3.1.3.3), hardware damage was discovered at drain line connections on two rocket engine assemblies; engine positions 4 and 7. The 9512-48246 union for the secondary lox seal drain connection on engine 4 had two deep scratches in the first and second threads, and a similar union in the engine-7 primary lox seal drain connection was severely scratched on the 37-degree sealing surface. In both cases, the damage was at the B-nut end caused by normal wear and tear. Both lox seal drain connections were opened numerous times during S-IB-5 assembly and test. Rocketdyne replaced the subject drain unions on engines 4 and 7 during the modification and refurbishment period.
Reference: DMN M17696 and DMN M18002

4.2.2.16 GG Combustion Chamber Seal Assembly (All Engines). In-house storage inspection disclosed that an unspecified nonflight item was installed in each of the rocket engine assemblies on stage S-IB-5. The RX20887 GG combustion chamber seal

assembly (also known as "Kennedy Plug") had been installed at MSFC subsequent to static test operations. "Kennedy Plugs" have been cancelled from engine configuration by ECP ET-20653, effective for S-IB-3 and subsequent stages. Consequently, the "Kennedy Plugs" were removed from each engine and replaced by the specified RX20628 GG attach flange closure assemblies. Replacement was accomplished during the modification and refurbishment period. Corrective action has been taken by the Systems Static Test Branch at MSFC to ensure that the correct closure assemblies are installed after static test operations, effective for S-IB-8 and subsequent stages. The proper closures have been installed on all current stages at MAF. Reference: DMN M16795A

## 4.2.3 INSTRUMENTATION AND TM SYSTEMS

Significant failures and discrepancies recorded on instrumentation and TM components are described in the following paragraphs.

### 4.2.3.1 Actuator Beta Potentiometers.

4.2.3.1.1 During storage of stage S-IB-5, subsequent to replacement of 062-42282 actuator beta potentiometers with 062-45512 potentiometers as directed by ECP ET-40538R3 (refer to paragraph 2.2.5), several of the new-configuration potentiometers failed to pass humidity qualification test. Disassembly analysis of these test potentiometers revealed the cause to be a lack of specified potting encapsulation behind the associated electrical receptacle. Further investigation confirmed that the potting was missing in all 062-45512 potentiometers that had been received from the vendor. It should be noted that this potting was specified on the vendor's drawing, but the manufacturer failed to implement. Those potentiometers modified by CCSD at MAF contained this potting.

4.2.3.1.2 During the aforementioned actuator beta potentiometer changeout on stage S-IB-5, vendor-supplied potentiometers were installed. The remaining vendor-supplied potentiometers had been put in stock or installed on other S-IB stages; therefore, it was necessary to purge these potentiometers and perform rework to specification at MAF in compliance with PAN 9. Consequently, the eight actuator beta potentiometers were again

removed from the 60C60001 servo actuators on stage S-IB-5 to undergo rework and were replaced by reworked potentiometers as indicated in table 4-2.

Table 4-2. Replacement of Actuator Beta Potentiometers

| Engine Position | Servo Actuator | Removed SN | Replaced SN |
|---|---|---|---|
| 1 | Pitch<br>Yaw | 6GE164<br>6GE144 | 6GE158<br>6GE159 |
| 2 | Pitch<br>Yaw | 6GE163<br>6GE148 | 5G854<br>4AG316 |
| 3 | Pitch<br>Yaw | 6GE160<br>6GE168 | 6GE157<br>5D12 |
| 4 | Pitch<br>Yaw | 6GE170<br>6GE165 | 6GE146<br>6GE150 |

4.2.3.2 Temperature Gauge (Measurement C61-1). While preparing the stage for shipment, inspection revealed damaged insulation on one helicon lead of temperature gauge 50C10099, serial number RA0834. The damage was located 0.375 inch from the red helicon connector and conductor was exposed. In compliance with MRB repair instructions, both helicons were cut off approximately 0.50 inch to maintain equal length and new connectors were installed. Heat-shrinkable tubing was put over the connectors and leads to prevent future damage. Measurement C61-1 will be verified during normal systems testing at KSC.
Reference: DMN M18802

4.2.3.3 Temperature Measurements (C61-3 and XC89-6). In-house storage inspection in the engine area found damaged leads on four individual components for measurements C61-3 and XC89-6. One 50C10099 temperature gauge for measurement C61-3, serial number RA0832, had an exposed wire at one helicon lead and an abraised area on the other. Another similar temperature gauge for the same measurement, serial number RA0825, had torn and frayed insulation with no exposed

wires. In measurement XC89-6, frayed insulation was found at one helicon connector on temperature gauge 50C10413, serial number RA0956, and a 0.100-inch crack was discovered in one lead of the associated 50C10403 zone box, serial number 231. Repair of temperature gauge 50C10099, serial number RA0832, consisted of removing the helicon connectors, installing shrinkable tubine over the damaged leads, and installing a new helicon connector. The less severe damage on the other two temperature gauges and the zone box was repaired by wrapping the leads with Mystik Tape 7503 covering the damaged areas.
Reference: DMN M18014

4.2.3.4 Zone Box (Measurement C600-7). During storage, while replacing a helicon connector on zone box 50C10402, serial number 251 (reference: squawk K23641), the positive lead (black wire) was found to have mashed teflon insulation. No breaks or cracks were noted, but the conductor was visible through the insulation. Since length would remain within specifications, the black wire was trimmed back past the deformed area and the helicon connector was replaced.
Reference: DMN M15457

4.2.3.5 Pressure Transducer (Measurement D119-9). During modification and refurbishment, a seepage of oil was noted where the electrical receptacle joins the housing of pressure transducer 50C10396, serial number 4-4778, for measurement D119-9. Visual inspection disclosed that the receptacle had become loose in the housing of the transducer. Subsequently, transducer serial number 4-4778 was replaced in the stage by serial number 4-1910 and returned to the vendor for rework.
Reference: DMN M18397

4.2.3.6 TM Assemblies.

4.2.3.6.1 Following removal in compliance with WAN 165I (refer to paragraph 2.3.10), five TM assemblies were visually inspected for conformance to QCI 40517 (conformal coating, MSFC-Procedure-257A and MSFC-Procedure-293A), QCI 75008 (procedure for inspection of electrical connections), and MSFC-Procedure-158A (solder). Noted nonconformances were recorded on DMNs, then accepted or corrected as determined by MRB disposition.

4.2.3.6.2 Thirteen nonconforming subassemblies found during inspection of RDSM (9A700) 50C12088-3, serial number 008, were listed on DMN M18026. All were dispositioned acceptable by MRB.

4.2.3.6.3 Inspection results from TM calibrator assembly (13A495) 50C12011-3, serial number 13, showed five nonconforming subassemblies which were listed on DMN M18028. Four were accepted by MRB; however, rework was required on PWA T40041, serial number 013, which was corroded and discolored. As directed by MRB repair instructions, the conformal coating was removed as required and the corroded and discolored areas were swabbed with hot oxalic acid then neutralized using sodium bicarbonate paste. The PWA was rinsed clean with distilled water, dried, and new conformal coating was applied in accordance with MSFC-Procedure-293.
Reference: DMN M18030

4.2.3.6.4 Thirty-three subassemblies had nonconformances in PCM/DDAS assembly (13A485) 60C50079-3, serial number 001, which were listed on DMN M18031. All nonconformances except the following were accepted by MRB:

a. PWA 50C01836-1, serial number BY23, had a damaged resistor (R11) and cracked solder joints at two transistors (Q1 and Q2) adjacent to the damaged resistor. The resistor was replaced and the solder joints reworked.
Reference: DMN M18029

b. PWA 50C01981-3, serial number BR50, had one cracked solder joint at terminal E1. Rework was accomplished.
Reference: DMN M18033

4.2.3.6.5 In TM multiplexer (13A484) 60C50081-21, serial number 010, thirty-eight nonconforming subassemblies were found and listed on DMN M18032. All were dispositioned acceptable by MRB with the exception of the following:

a. PWA 410345, serial number BD72, had insulation damage on one lead to inductor L1 exposing the conductor. Repair was accomplished by applying conformal coating to the damaged area.
Reference: DMN M18037

b. PWA 410342, serial number BF59, had three pins, in back of the connector, not properly coated and one damaged wire at terminal E6. Serial number BF59 was replaced in the multiplexer by serial number AS68 and was subsequently reworked.
Reference: DMN M18034

c. PWA 410355, serial number BK54, had one damaged resistor (R71) and minor discolorations. Serial number BK54 was replaced in the assembly by serial number AZ96 and was later reworked.
Reference: DMN M18036

4.2.3.6.6 TM multiplexer (13A440) 60C50081-19, serial number 009, contained thirty-eight nonconforming subassemblies which were listed on DMN M18035. All nonconformances were accepted by MRB with the exception of the following:

a. PWA 410351, serial number BF85, had insufficient solder at the base lead of transistor Q4. Rework was accomplished.
Reference: DMN M18042

b. PWA 410362, serial number BZ05, had one cracked solder joint at connector pin "J". Rework was accomplished.
Reference: DMN M18040

4.2.3.6.7 It should also be noted that during inspection of each TM assembly, several additional minor discrepancies were found. Prior to reassembly and final acceptance, each assembly required a thorough cleaning and correction of minor hardware

discrepancies such as loose Allen screws, improper lockwiring, and/or damaged screws.
Reference: DMN M18026, DMN M18028, DMN M18031, DMN M18032, and DMN M18035

4.2.3.6.8 An extensive investigation was initiated by CCSD Engineering to determine the cause and recommend corrective action for cracked solder joints on the PWAs. The cause was attributed to different coefficients of expansion as the assemblies heat up during use. ECP EP-51322 was initiated and submitted for approval to replace the advance VCO subassemblies with class-I VCO subassemblies in the TM packages of stages S-IB-5 through S-IB-12. The class-I VCO subassemblies have been redesigned to reduce the causes of cracked solder joints. Specifically, the transistors have heat sinks and the spacer has been eliminated from the subassembly, thus reducing or eliminating the conformal coating between the transistor bulkhead and printed wiring board. Upon approval, ECP EP-51322 will be incorporated in S-IB-5 TM packages during prelaunch operations at KSC.

4.2.3.6.9 Additional investigation has disclosed that in fabrication of printed wiring boards, an unwanted compound, gold cyanide, is deposited as well as pure gold during the gold electroplating process. This results in porosity and surface irregularities in solder joints. Although this is an undesirable condition, it has not caused the failure of any solder joints. Corrective action consisted of submitting ECP ET-51317 for approval, to be effective for S-IB-13 and subsequent stages. The intent of ECP ET-51317 is to change the plating of swage-type terminals from gold to solder on designated printed wiring boards and assemblies. NASA approval had not been obtained at the time of writing.

4.2.3.7 RDSM (9A700).

4.2.3.7.1 During preparation for shipment, after removing RDSM (9A700) 50C12088-3, serial number 008, for power supply design change (refer to paragraph 2.2.4.3), several nonconformances were discovered on the 50M11924-3 PWA that was to be installed (a GFP item). Both guide pins and contact pins "A", "B", and "a" were bent on the connector

block, one component (C1) was improperly mounted, holes and pits were noted on three solder joints, and a hair or bristle was in the conformal coating, across the conductor pattern.

4.2.3.7.2 After investigation, NASA dispositioned that CCSD repair the PWA so as to render it usable for test. This consisted of straightening the bent pins and removing the hair from the PWA which required removal and reapplication of conformal coating. The other nonconformances were considered acceptable for test purposes. Following repair, the PWA was reinstalled in the RDSM which was then returned to the stage.

4.2.3.7.3 In compliance with NASA disposition, RDSM serial number 008 was tagged "not for flight use". The unflightworthy PWA is to be replaced at KSC when an acceptable PWA is made available by CCSD Materials Branch.
Reference: DMN M18878 and GFP Rework Work Order 68-3-416

4.2.3.8 TM Assembly (13A450). While modifying TM assembly (13A450) 60C50142, serial number 001 (refer to paragraph 2.2.10.1), it was discovered that the 50M66172-1 cover gasket and three AN960-6L washers were not included in the assembly. Also, all MS35206-22B pan-head screws exhibited burrs and sharp edges caused by numerous opening and closing of the assembly cover. The missing gasket and washers were installed during reassembly following modification and pan-head screws were replaced as necessary.
Reference: DMN M18092

4.2.3.9 PCM/DDAS Assembly (13A485).

4.2.3.9.1 Just prior to post storage reverification checkout, PCM/DDAS assembly (13A485) 60C50079-3, serial number 001, was removed from the stage for special inspection (refer to paragraph 2.3.11). It had been determined that the subject assembly contained one PWA that was reworked in the same time period as other reworked PWAs found to have discoloration of "Hysol" conformal coating.

4.2.3.9.2 Internal inspection of the PCM/DDAS assembly disclosed that PWA 50C01836-1, serial number BY23, had discolored conformal coating on the circuit side of the board and one cracked solder joint at the collector lead of transistor Q2 (cracked solder joints are covered, with corrective action, in paragraph 4.2.3.6). All other PWAs were found to be acceptable. PWA serial number BY23 was replaced by PWA serial number BX99, reworked, and returned to stock. Following replacement of the PWA, the PCM/DDAS assembly was tested and reinstalled on the stage.
Reference: DMN M18423

4.2.3.9.3 Investigation by CCSD Materials Engineering has revealed two causes of discolored conformal coating. Specifically, (1) when a PWA, covered with an excessive conformal coating or coating with improperly mixed catalyst, is exposed to heat or light, and (2) in cases where the PWA was inadequately rinsed after use of freon passive cleaning agent. Corrective action is strict adherence to MSFC-Procedure-257A (Procedure for Conformal Coating of Printed Circuit Assemblies) and to the recently approved MEP 5501.4, Revision 2 (Conformal Coating of Printed Circuit Boards).

4.2.3.9.4 CCSD action has been the revision of the aforementioned MEP 5501.4. Essentially, the procedure changes call for a longer mixing period and specifies that, after mixing, the "Hysol" shall be poured, not scraped, from the mixing bowl. It is also specified that application of the mixture should be delayed until such time that maximum viscosity is achieved. This will minimize the possibility of diffusion of colored amine products when epoxies of different age groups come in intimate contact with one another.

## 4.2.4 STRUCTURES

Significant failures and discrepancies recorded on structural components and assemblies are described in the following paragraphs.

4.2.4.1 Flame Curtains (Engines 1, 2, 3, and 4).

4.2.4.1.1 In-house storage inspection revealed a number of snaps on the 30C03566 flame curtains could not be aligned properly on engines 1, 3, and 4. Repair consisted of aligning the snaps as closely as possible and drilling 0.187-inch diameter holes through the curtains, between the misaligned snaps. A screw, two washers, and a nut were then installed in each hole. Also noted at this time were two angular torn spots on the flame curtains of engine 1 (0.25 by 1.00 inch) and engine 4 (0.25 by 0.50 inch). Both tears were repaired by patching the damaged areas with refrasil material as directed by MRB repair instructions.
Reference: DMN M16286 and DMN M16293

4.2.4.1.2 During modification and refurbishment, while removing flame curtains to facilitate post storage reverification checkout, damage was incurred on each outboard engine flame curtain. Damage was in the form of loose, defective, or missing snap fasteners; cuts, nicks, or cracks in the silicone rubber batt; and torn, peeled, or chafed refrasil material. Repair was accomplished, directed by MRB repair instructions, as follows:

a. Snap fasteners were replaced or in cases where necessary, a screw, two washers, and a nut were installed in lieu of fasteners.

b. RTV 116 red, self-leveling adhesive was applied to the silicone rubber batt to provide a smooth surface.

c. New end panels were installed, refrasil patches and/or sealant were applied as necessary to repair or patch refrasil material.

Reference: DMN M18006

4.2.4.2 Container Unit Assemblies, Lox 1 through 4.

4.2.4.2.1 While implementing rework requirements as part of the structural improvement in the forward skirts of the 70-inch lox containers (refer to paragraph 2.2.7), inspection discovered

a number of rivet irregularities. Ten rivets had shanked heads in each of container unit assemblies, lox 1 and lox 4. Twenty rivets had shanked heads in lox 2; and in lox 3, fifteen rivets had shanked heads and 38 rivet holes were elongated.

4.2.4.2.2 Both irregularities were caused by the same condition; the rivet holes in the containers, drilled to aluminum rivet tolerances by the manufacturer (LTV), were not sufficiently aligned or perpendicular to meet the close tolerances that are required for proper installation of the steel rivets which is part of the structural improvement modification (ECP FT-30867R1).

4.2.4.2.3 Since no shanked rivet exceeded 0.016 inch at any measured point under the rivet head, a use-as-is disposition was given by MRB. Repair of the elongated holes was accomplished by opening the holes to a larger size (from 0.203/0.205-inch diameter to 0.247/0.249-inch diameter) and installing NAS-1468-5 lockbolts with NAS-1080-8 collars in the oversized holes.

4.2.4.2.4 As a result of these and similar rivet irregularities found while incorporating structural improvement of stage S-IB-6, Standard Repair 010 was issued, effective for stages S-IB-7 through S-IB-12. This procedure established criteria for rejection and repair methods. Also, tooling aids were fabricated to more effectively install the close-tolerance steel rivets. For stages S-IB-10 through S-IB-12, inspection for rivet hole perpendicularity was conducted prior to modification. No further corrective action is required as modified containers will be furnished by LTV, who have been made aware of the problem, for stages subsequent to S-IB-12.
Reference: DMN M16492, DMN M16494, DMN M16496, DMN M16498, and DMN M16499

4.2.4.3 Heat Shield Panel Assembly. When heat shield panel assembly 60C30559 was removed from the stage and placed in storage (refer to paragraph 1.2.1), damage was incurred when personnel accidently dropped the panel. Two cracks were repaired by stop drilling on the forward side of the panel. One crack was 0.300 inch in length, and the other 0.400 inch in length. Also found were seven dents ranging from 0.005 inch to 0.010 inch in depth. Dye penetrant checks were performed

around the damaged area and no additional damage was found. MRB disposition was to use as is with the aforementioned repairs.
Reference: DMN M15336

## 4.3 POST STORAGE REVERIFICATION CHECKOUT

The significant failures and discrepancies described under heading 4.3 either occurred or were discovered by means of inspection or test during post storage reverification checkout. Where applicable, the specific functional acceptance test procedure being conducted when a failure occurred is referenced in the paragraph covering the failure. Since a specific procedure may be identified by its final two digits, the complete procedure number is not referenced. For example, procedure 2-CM-IB-205F-3.3 is referenced as procedure 3.3 in paragraph 4.3.3.6. In instances where system components were removed from the stage and repaired or reworked, component level retest was accomplished prior to reinstallation. Systems which incurred any form of rework, removals, or replacements during post storage reverification checkout were verified and accepted during functional checkout.

### 4.3.1 ELECTRICAL SYSTEMS

Significant failures and discrepancies recorded on electrical components and assemblies during post storage reverification checkout are described in the following paragraphs.

#### 4.3.1.1 Propulsion Distributor Assembly (9A1).

4.3.1.1.1 During component level test of propulsion distributor assembly (9A1) 60C41054, serial number SA0658, subsequent to diode replacement (refer to paragraph 2.3.13.2), low insulation resistance was indicated between the 1D11 bus and the 1DCOMM bus. Visual inspection showed that one relay (K33) had an excessive amount of flux so all relays were cleaned. The distributor was oven baked to evaporate possible moisture and electrical test was resumed. A low insulation resistance problem was again encountered.

4.3.1.1.2 Investigation verified that the problem area in the subject distributor was in the vicinity of diodes CR12, CR13, and CR14, but trouble shooting methods determined that the circuitry was not the cause. The insulation resistance loss had occurred on the under side of the terminal board, between the diode terminals on the outer row.

4.3.1.1.3 X-rays were made in the suspect area which revealed no wires or hardware in or around the potting to which a partial short could be attributed. The potting foam was then removed in which a brown discoloration was noted; however, the exact cause of the low resistance reading could not be determined. New potting foam was then installed and the terminal board reworked after which acceptable electrical tests were achieved. Subsequently, propulsion distributor serial number SA0658 was reinstalled on the stage.
Reference: FEADS 3027

4.3.1.1.4 Problems of this nature are caused by rework of finished electrical assemblies. Alcohol and flux may pass through hollow feed-through terminals during rework and lay in the small gap between the bottom side of the terminals and the base potting. If this type condition should ever recur, it will be discovered during electrical test and corrected prior to reinstallation of an assembly into the system. In the distributors of stages S-IB-9 through S-IB-12, conformal coating has been applied to the bottom side of terminal strips as well as the top in compliance with ECPs EP-40585 and ET-40591. This provides additional protection against rework-oriented discrepancies such as air pockets and flow of solvents through the terminals.

4.3.1.2 Hypergol Igniter Monitor Switch (Engines 3 and 5). After initial application of stage power, the HYPERGOL INSTALLED indication was not received from engines 3 and 5. Investigation revealed that the engine-3 hypergol igniter monitor switch NA5-27189T1-1A, serial number 106, was completely inoperative, and the electrical connector was broken away from the unserialized NA5-27189T1-1B hypergol igniter monitor switch on engine 5. The cause of the broken receptacle was attributed to hand and foot damage since protective hypergol covers had not been incorporated for stage S-IB-5. Rocketdyne personnel replaced the hypergol switches on engines 3 and 5 with unserialized switches under CCSD and NASA

surveillance. The damaged switch from engine 5 was scrapped and switch serial number 106 was retained by Rocketdyne for failure analysis. Protective covers were installed over the hypergol and TOP switches at a later date during reverification checkout (refer to paragraph 2.2.29).
Reference: DMN M18491 and DMN M18492

## 4.3.2 MECHANICAL SYSTEMS

Significant failures and discrepancies recorded on mechanical components and assemblies during post storage reverification checkout are described in the following paragraphs.

### 4.3.2.1 Fuel and Lox Shutoff Valves (Prevalves, Engine 4).

4.3.2.1.1 During the valve timing segment of Components Test procedure A6.0, the engine-4 lox shutoff valve 60C20339, serial number 143, was out of specification. The standard procedure of replacing the control orifice to obtain proper operation was attempted six times with no success. The control orifice in the related engine-4 fuel shutoff valve 60C20340, serial number 144, was then examined and found to be loose. The loose orifice in fuel shutoff valve serial number 144 was torqued 50 to 75 inch-pounds and an O-ring was installed under the control orifice of lox valve serial number 143 which was then torqued to 25 ± 5 inch-pounds. These actions corrected the engine-4 valve timing.
Reference: FRADS 3025

4.3.2.1.2 It should be noted that a recent assembly revision by the vendor (Parker Aircraft Co.) has been the installation of O-rings under the control orifice of 60C20339 valves, effective for 159 and subsequent serial numbers, and 60C20340 valves, effective for 158 and subsequent serial numbers. The torque requirement with an O-ring installed is 25 ± 5 inch-pounds.

4.3.2.1.3 An inspection of control orifices was made in the control piston housings of the 14 remaining shutoff valves on stage S-IB-5. It was found that the control orifice installation was loose in seven shutoff valves. These seven valves were manufactured prior to the vendor revision mentioned in the previous paragraph; therefore, did not contain O-rings. Each loose control orifice was torqued to 50 to 75 inch-pounds as is required without the O-ring.

4.3.2.1.4 PAN 54 was generated to verify and retorque control orifices to the aforementioned specifications (with and without O-rings) in all shutoff valves of stage S-IB-6 through S-IB-12. To provide further corrective action, Receiving Inspection QCIs 62834 and 62835 were issued directing a control orifice torque check. Vendor documentation now specifies torque requirements.

NOTE

The lox shutoff valves for engine 4 and 5, serial numbers 143 and 167 respectively, are the only shutoff valves on stage S-IB-5 that contain an O-ring under the control orifice. All other shutoff valves were manufactured prior to the vendor assembly revision.

4.3.2.2 Tube Assembly (Engine 2). During inspection prior to preparation for shipment, a minor seepage leak was noted on engine-2 hydraulic package 60C20748, serial number 148. The seepage was located where tube assembly 60C20887 connects to the accumulator, between the B-nut and the MC165C6 elbow. The tube assembly was disconnected from the elbow for examination and subsequently replaced on the package. Following tube assembly replacement, the hydraulic system was purged and filled in compliance with QCI 50012, revision 6. Hydraulic system testing will be accomplished during normal prelaunch checkout at KSC.
Reference: FEADS 3044

4.3.2.3 Fuel Fill and Drain Valve (Fuel 1). While testing in compliance with Fuel System procedure 4.4, excessive leakage was noted past the main gate seal of fuel fill and drain valve 60C26025-3, serial number 112. The leakage rate was 13.6 scim, as recorded on a Brooks Flowmeter, with 5 scim being the maximum allowed. Consequently, valve serial number 112 was replaced on the stage by serial number 102 and moved to the clean room for disassembly analysis which disclosed metal particles on the lip seal. The lip seal was replaced and valve serial number 112 was reworked and returned to stores.
Reference: FEADS 3021

## 4.3.3 INSTRUMENTATION AND TM SYSTEMS

Significant failures and discrepancies recorded on instrumentation and TM components during post storage reverification checkout are described in the following paragraphs.

4.3.3.1 Measurement C600-7. While conducting UMA Scan and Calibrate procedure A3.0, no output was received from measurement C600-7 in the RUN mode. Investigation revealed that one helicon connector was broken off of temperature gauge 50C10100, serial number 0009, and two helicons were broken from the associated 50C10275 thermocouple extension cable. In addition, the extension cable leads leading to the helicons had become brittle. It should be noted that the components for measurement C600-7 were removed and reinstalled during previous operations (refer to ECP ET-51164, ECP ET-51187, and DMN M15317). Temperature gauge serial number 0009 was replaced by serial number RA2361 and a new extension cable was installed. Heat-shrinkable tubing 5-2272 was put over the helicon connectors and the leads at the connectors as a protective measure.
Reference: FFADS 2179, DMN M18493, and DMN M18497

4.3.3.2 Pressure Transducer (Measurement D14-4). While testing in compliance with Pressure procedure 3.4, an out-of-tolerance output was received from measurement D14-4. With 40 psia applied to the 50C10397 pressure transducer, serial number 6-6285, measurement output was 8.2 percent-full-scale with the maximum calibration curve limit being 7.43 percent. Retest showed that the measurement was out of tolerance throughout the range. Therefore, transducer serial number 6-6285 was replaced on the stage by serial number 4-1922 and held for functional failure analysis which was incomplete at time of writing.
Reference: FFADS 2178

4.3.3.3 Pressure Transducers (Measurements D34-1 and D34-8). While performing Dynamic Pressure procedure 3.19, erratic outputs were recorded from measurements D34-1 and D34-8. Investigation determined that the 50C12325 pressure transducers for the respective measurements were the cause of the malfunction. Subsequently, pressure transducers serial numbers 6-9268 (D34-1) and 7-7954 (D34-8)

were replaced on the stage by serial numbers 6-9272 and 29-668 then returned to the vendor for failure analysis which had not been received at time of writing.
Reference: FFADS 3008 and FFADS 3009

4.3.3.4 Pressure Transducer (Measurement D122-3).

4.3.3.4.1 During test in compliance with Pressure procedure 3.4, the output from differential pressure measurement D122-3 was 8 to 14 percent below the calibration curve value at any given point of the range. Procedural tolerance is ± 2 percent from the curve value. Consequently, pressure transducer 50C10306, serial number 8-2165, was removed for failure analysis and subsequently scrapped. Transducer serial number 4-6611 was installed as the replacement.

4.3.3.4.2 Failure analysis of transducer serial number 8-2165 showed the cause of failure to be overpressurization. Measurement D122-3 is a differential transducer with a range of ± 5 psid. If an absolute pressure is inadvertently selected on the pressure console instead of gauge pressure, a vacuum will be drawn and the transducer will be subjected to a negative pressure in excess of the 7.5-psi proof pressure which can be tolerated by the transducer. Damage will result.

4.3.3.4.3 To provide corrective action for overpressurization of low-range pressure transducers, cautionary notes have been added to the applicable functional acceptance test procedures to draw the operator's attention to possible overpressurization. Also, relief valves have been provided for all manifold pressure ranges in the pressure test console.
Reference: FFADS 3020

4.3.3.5 Pressure Transducer (Measurement D600-8).

4.3.3.5.1 While testing in accordance with Pressure procedure 3.4, the response of measurement D600-8 was above the calibration tolerance with 1 psia applied. The actual value received was 11.5 percent-full-scale with a predicted value and procedure tolerance of 9.1 ± 2 percent-full-scale. Pressure transducer 50C10259, serial number M2096, was replaced in the measurement by serial number M2092 which, after test was resumed, was also found to be out of tolerance. The output

from transducer serial number M2092 exceeded the predicted values by 5.30, 3.66, and 3.98 percent with respective applied pressure of 1, 10, and 18 psia.

4.3.3.5.2 During installation of a second replacement transducer, serial number M2354, it was noted that one CNO-2 mounting bolt insert was loosened in the 60C11354 flame shield support assembly on which the subject measurement is secured. Repair was performed in compliance with MRB instructions to effect a satisfactory mount. Transducer serial number M2354 was then installed and tested with acceptable results. Transducers serial numbers M2096 and M2092 were subjected to functional failure analysis and subsequently scrapped.
Reference: DMN M18498

4.3.3.5.3 Failure analysis of transducers M2096 and M2092 revealed that both transducers had been subjected to pressures in excess of their proof pressure or capacity. Measurement D600-8 has a pressure range of 0 to 20 psia. If the test operator was to inadvertently select "gauge" pressure instead of "absolute" pressure on the pressure test console, the applied pressure will exceed the proof pressure of the transducer resulting in damage. Corrective action is as described in paragraph 4.3.3.4.3.
Reference: FFADS 3007 and FFADS 3022

4.3.3.6 DC Amplifiers (Measurements XC89-1 through XC89-8).

4.3.3.6.1 While testing in compliance with Temperature procedure 3.3, the output from each gearcase lubricant temperature measurement (XC89-1 through XC89-8) was low in the RUN mode. Four measurements were below tolerance. During trouble shooting, the ambient temperature was recorded and compared with the temperature equivalents of the measurement outputs. The comparison showed a difference of as much as 6 degrees C. This indicated that the 50C10394-113 DC amplifiers associated with the subject measurements were marginal and/or miscalibrated. Each of these amplifiers was last calibrated during October 1965. Amplifiers serial numbers 2067 (XC89-1), 2003 (XC89-2), 2074 (XC89-3), 2075 (XC89-4), 2081 (XC89-5), 2069 (XC89-6), 2076 (XC89-7), and 2071 (XC89-8) were removed from the stage for recalibration as recommended by QC Engineering.

4.3.3.6.2 During recalibration of DC amplifiers serial numbers 2069 and 2075, it was discovered that the nut used to secure the toroid transformer inside the amplifier was loose. In serial number 2081, the nut and washers had come off and were laying free within the housing. This was caused because the vendor had failed to apply a securing agent (locktite) on the threads, prior to installing the nut on the transformer. The nuts and washers were resecured and each amplifier was recalibrated and returned to the stage.

4.3.3.6.3 As corrective action regarding loose transformer nuts, the vendor has been notified and has stated that a self-locking nut is now used to secure the toroid transformer. PAN 56 was initiated to inspect all DC amplifiers in stock to assure that the self-locking nut is installed or the securing agent is on the threads. Investigation regarding this problem and PAN 56 was still in progress at time of writing.
Reference: FFADS 3012, FFADS 3013, FFADS 3014, FFADS 3015, FFADS 3016, FFADS 3017, FFADS 3018, and FFADS 3019

4.3.3.7 Pressure Transducer (Measurement XD35-5). During Dynamic Pressure procedure 3.19, the output from measurement XD35-5 became erratic while pressurizing through the range. With the input approximately 300 psia, the output from the associated 50C12325 pressure transducer, serial number 7-7957, deviated from the mean dynamic curve by as much as 200 mv. The procedural tolerance is ± 100 mv. An additional run was made which verified the malfunction. Consequently, pressure transducer serial number 7-7957 was replaced by serial number 6-6166B and held for failure analysis which was in progress at time of writing.
Reference: FFADS 3010

4.3.3.8 Measurement Calibrator (Measuring Rack 9A516). During Control System procedure 9.0, all measurements in measuring rack 9A516 remained in the HI-cal mode, regardless of mode selection. Measurement calibrator 50C66811, serial number 243, was replaced in the measuring rack by serial number 296 which functioned correctly. Subsequent tests performed on measurement calibrator serial number 243 failed to duplicate the malfunction; therefore, serial number 243 was returned to stock.
Reference: FFADS 2177

4.3.3.9 PCM/DDAS Assembly P1 (13A485).

4.3.3.9.1 During automated test in compliance with General Networks Malfunction Cutoff Test Number 1 procedure A5.0, steady full-scale readings (logic 1) were received from PCM/DDAS assembly P1 (13A485) 60C50079-3, serial number 001, through all channels that originate as an analog input (from the TM multiplexers). The synchronization words and the RDSM channel, both digital inputs to the PCM/DDAS assembly, were functioning correctly. The malfunction occurred after power had been applied to the PCM/DDAS assembly for approximately 1 hour.

4.3.3.9.2 PCM/DDAS assembly serial number 001 was removed from the stage and subjected to environmental and functional tests in the TM Laboratory. It was determined that when the subject PCM/DDAS assembly was exposed to temperatures of 50 degrees C, failure would occur as previously described. Consequently, analog to digital (A to D) converter 60C00293, serial number 88, a kit consisting of 12 PWAs, was replaced in the PCM/DDAS assembly by A to D converter serial number 69.

4.3.3.9.3 During subsequent tests, A to D converter serial number 69 did not meet the tolerances of the accuracy test (QCI 62540) and was therefore replaced by A to D converter serial number 72 which tested satisfactorily. After functional test, PCM/DDAS assembly serial number 001 was reinstalled on stage S-IB-5.

4.3.3.9.4 A to D converters serial numbers 88 and 69 were returned to CCSD-Huntsville for failure analysis. Serial number 69 was installed into another PCM/DDAS assembly, serial number 004, which was functionally tested with acceptable results; therefore, no further analysis was performed. Failure analysis for serial number 88 had not been received at time of writing.
Reference: FFADS 3023 and FFADS 1812

4.3.3.10 PCM/RF Assembly P1 (13A486). While testing in compliance with TM System procedure 7.2, the power output from PCM/RF assembly 50C12187-1, serial number 009, was 1 watt below the specified minimum limit of 13 watts. A similar

problem had been encountered during prestatic functional checkout operations (refer to paragraph 5.3.3.18 of the basic publication) which resulted in the installation of serial number 009 as a replacement assembly. Though the PCM/RF assembly that had been previously removed was found to function correctly, malfunction verification tests proved that serial number 009 was indeed out of tolerance. The highest power output recorded was 12.9 watts. PCM/RF assembly serial number 009 was replaced on the stage by serial number 001 and returned to the vendor for failure analysis which had not been received at time of writing.
Reference: FFADS 2176

4.3.3.11 Range Safety Decoder (13A500).

4.3.3.11.1 Prior to initial application of power, inspection revealed that coaxial receptacles 13A500J2 and 13A500J3 were loose in the housing of range safety decoder 50M10698, serial number 0038. The receptacles are secured by a locknut and washer without the benefit of a D-shaped hole or other locking arrangement in the housing. Decoder serial number 0038 was replaced on stage S-IB-5 by serial number 0198 and returned to MSFC-Huntsville for rework.

4.3.3.11.2 No corrective action can be taken by CCSD regarding discrepant range safety decoders as the unit is GFP. Disposition on these assemblies is strictly the responsibility of MSFC-Huntsville. When a defective unit is returned to MSFC for repair, two holes are drilled through the shoulder of the receptacle and into, but not through the panel face. Rolled dowel pins are then inserted. This fix is also performed during assembly of new units to prevent receptacle rotation and was initiated as corrective action after a discrepancy was found on stage S-IB-10 (UCR 06510). Since this has been a recurrent problem and no retrofit has been scheduled for units already in service, documentation has been provided to direct inspection of range safety decoders on stages S-IB-7 through S-IB-12 subsequent to in-house storage. Replacements will be made as required.
Reference: DMN M18487

4.3.3.12 DDAS Random Pulses. While conducting General Networks Malfunction Cutoff Test Number 1 procedure A5.0, numerous DDAS discrete functions were noted to pulse during test segments when the CUTOFF RESET command was given. Also, one DDAS discrete function (switch selector pulse count) was erroneously received during several test segments upon initiation of STAGE LOGIC RESET command. These commands are test oriented and are not given during actual flight conditions. Therefore, these phenomena are not considered stage defects (refer to paragraph 5.3.3.22 of the basic publication).
Reference: FFADS 3024 and FFADS 3041

## 4.3.4 STRUCTURES

One significant structural discrepancy was encountered during post storage reverification checkout and is described in the following paragraph.

### 4.3.4.1 Fuel Ring Manhole (Fuel 4).

4.3.4.1.1 While installing fuel burst disc assembly SEQ 3506 in the forward end of fuel-4 container unit assembly, a requirement of Fuel System procedure 4.4, the torque on one bolt became excessive before the bolt was completely seated. The bolt was removed which revealed that the threads of the heli-coil insert in fuel ring manhole 30C00215 were damaged. Repair was accomplished by removing the damaged heli-coil insert, enlarging the tapped hole, and installing an oversize heli-coil insert.
Reference: DMN M18490

4.3.4.1.2 Installation of the burst disc assembly was continued and two additional damaged heli-coil inserts were found. In compliance with MRB repair instructions, the damaged inserts were replaced by oversize inserts in the manner previously described.
Reference: DMN M18494 and DMN M18495

4.3.4.1.3 Prompted by the discovery of damaged inserts in the fuel ring manhole, a check was conducted on each of the 24 heli-coils in the ring. The check indicated that the majority of the inserts were undersize and therefore were unacceptable. After cleaning each insert with freon and visually inspecting each for particles and contamination in compliance with MRB repair instructions, acceptable conditions were met. The fuel burst disc assembly was then successfully installed.
Reference: DMN M18496

4.3.4.1.4 An investigation was undertaken by CCSD QC Engineering to determine the cause and establish corrective action for the heli-coil insert discrepancies. A review of fuel ring manifold drawing 30C00215 and fuel skin section assembly drawing 60C30391 disclosed that the taps drilled in the ring are for unplated corrosion resistant heli-coils MS124696, though the specified inserts are cadmium plated MS21208F-4-15. The minimum cadmium plating thickness is 0.0003 inch which causes a minimum pitch diameter growth of 0.0024 inch. This creates a marginal condition under the best installation practices. CCSD Design Engineering evaluation for corrective action for this condition was in progress at the date of this publication.

4.3.4.1.5 Further investigation disclosed that the container unit assembly supplier (LTV) taps and installs the heli-coils into the ring followed by inspection of the installation with a "go" and "no go" thread gage. The approved ring is then welded to the skin section assembly, but no further inspection is performed to assure that shrinkage has not occurred in the heli-coil installed holes. LTV has been made aware of this and has agreed to add inspection requirements after welding of future container assemblies.

# SECTION V

# FINAL CONFIGURATION DATA

## 5.1 SCOPE

The following paragraphs and tables provide a quick reference to specific information covering in-house storage, modification and refurbishment, post storage reverification checkout, and preparation for shipment of stage S-IB-5.

### 5.1.1 COMPONENT REPLACEMENT RECORD

Components and assemblies that were replaced due to failures, discrepancies, or modifications covered in this supplement are listed in table 5-1. In those cases involving removal and replacement of a component, the new component satisfactorily passed all functional requirements unless noted otherwise. Where applicable, the measurement number or reference designation number is given in parenthesis in the name column. The extreme right-hand column of table 5-1 contains a reference to the specific paragraph that documents the failure, discrepancy, or modification that caused the replacement. Table 5-1 is set up in part number order so that the respective paragraph pertaining to any particular component replacement can be readily located. For a complete list of all serialized components replaced, refer to the Component Removal and Installation Record listed on the Reference Documents page at the rear of the basic publication.

Table 5-1. Component Replacement Record

| Part Number | Name | Serial Number & Date Removed | Serial Number & Date Installed | Paragraph Reference |
|---|---|---|---|---|
| 062-42282 (062-45512 installed) | Actuator Beta Potentiometer (engine 1, yaw) | 5G749 1 Sep 66 | 6GE144 4 Nov 66 | 2.2.5 |
| 062-45512 | (engine 1, yaw) | 6GE144 14 Nov 66 | 6GE159 20 Dec 66 | 4.2.3.1 |
| 062-42282 (062-45512 installed) | (engine 1, pitch) | 4AG316 1 Sep 66 | 6GE164 7 Nov 66 | 2.2.5 |
| 062-45512 | (engine 1, pitch) | 6GE164 14 Nov 66 | 6GE158 20 Dec 66 | 4.2.3.1 |
| 062-42282 (062-45512 installed) | (engine 2, yaw) | 5C936 1 Sep 66 | 6GE148 4 Nov 66 | 2.2.5 |
| 062-45512 | (engine 2, yaw) | 6GE148 14 Nov 66 | 4AG316 19 Dec 66 | 4.2.3.1 |
| 062-42282 (062-45512 installed) | (engine 2, pitch) | 5A964 1 Sep 66 | 6GE163 4 Nov 66 | 2.2.5 |
| 062-45512 | (engine 2, pitch) | 6GE163 14 Nov 66 | 5G854 20 Dec 66 | 4.2.3.1 |

Table 5-1. Component Replacement Record (continued)

| Part Number | Name | Serial Number & Date Removed | Serial Number & Date Installed | Paragraph Reference |
|---|---|---|---|---|
| 062-42282 (062-45512 installed) (continued) | Actuator Beta Potentiometer (engine 3, yaw) | 5 1 Sep 66 | 6GE168 10 Nov 66 | 2.2.5 |
| 062-45512 | (engine 3, yaw) | 6GE168 14 Nov 66 | 5D12 19 Dec 66 | 4.2.3.1 |
| 062-42282 (062-45512 installed) | (engine 3, pitch) | 5C938 2 Sep 66 | 6GE160 10 Nov 66 | 2.2.5 |
| 062-45512 | (engine 3, pitch) | 6GE160 14 Nov 66 | 6GE157 16 Dec 66 | 4.2.3.1 |
| 062-42282 (062-45512 installed) | (engine 4, yaw) | 5G747 1 Sep 66 | 6GE165 4 Nov 66 | 2.2.5 |
| 062-45512 | (engine 4, yaw) | 6GE165 14 Nov 66 | 6GE150 20 Dec 66 | 4.2.3.1 |
| 062-42282 (062-45512 installed) | (engine 4, pitch) | 5G852 2 Sep 66 | 6GE170 10 Nov 66 | 2.2.5 |

Table 5-1. Component Replacement Record (continued)

| Part Number | Name | Serial Number & Date Removed | Serial Number & Date Installed | Paragraph Reference |
|---|---|---|---|---|
| 062-45512 | Actuator Beta Potentiometer (engine 4, pitch) | 6GE170 14 Nov 66 | 6GE146 16 Dec 66 | 4.2.3.1 |
| 20C00447 | Swivel Joint (lox bay 1) | 57 26 Sep 67 | 11 26 Sep 67 | 2.2.18 |
| | (lox bay 1) | 58 26 Sep 67 | 157 26 Sep 67 | 2.2.18 |
| | (lox bay 2) | 55 26 Sep 67 | 178 26 Sep 67 | 2.2.18 |
| | (lox bay 2) | 59 26 Sep 67 | 36 26 Sep 67 | 2.2.18 |
| | (lox bay 3) | 60 26 Sep 67 | 187 26 Sep 67 | 2.2.18 |
| | (lox bay 3) | 63 26 Sep 67 | 35 26 Sep 67 | 2.2.18 |
| | (lox bay 4) | 52 26 Sep 67 | 20 26 Sep 67 | 2.2.18 |
| | (lox bay 4) | 54 26 Sep 67 | 3 26 Sep 67 | 2.2.18 |

Table 5-1. Component Replacement Record (continued)

| Part Number | Name | Serial Number & Date Removed | Serial Number & Date Installed | Paragraph Reference |
|---|---|---|---|---|
| 20C30122-1 | 7-Inch Lox Vent Valve Assembly (lox 3) | CH104 5 Sep 67 | 863 23 Oct 67 | 2.2.25.3 4.2.2.5 |
| | (lox 4) | CH113 5 Sep 67 | CH106 23 Oct 67 | 2.2.25.3 4.2.2.5 |
| 20C30131 | Sphere Fill and Vent Valve | 159 6 Sep 67 | 147 14 Oct 67 | 4.2.2.2 |
| 20C30133 | Nipple (QD) (umbilical, lox 2-forward) | RA0714 3 Nov 66 | RA1827 3 Nov 66 | 4.2.2.3 |
| 20C30135 | 750 PSI $GN_2$ Control Pressure Switch | 25426 6 Sep 67 | 25353 5 Oct 67 | 2.2.18 |
| 20C30136 | Nipple (QD) (umbilical, lox 2-aft) | 0003 24 Oct 67 | RA2420 24 Oct 67 | 2.2.18 |
| 20C30138 | Nipple (QD) (umbilical, lox 4-aft) | RA0659 17 Nov 67 | RA3028 17 Nov 67 | 2.2.25.5 |
| | (umbilical, lox 4-aft) | RA0660 17 Nov 67 | RA3018 17 Nov 67 | 2.2.25.5 |

Table 5-1. Component Replacement Record (continued)

| Part Number | Name | Serial Number & Date Removed | Serial Number & Date Installed | Paragraph Reference |
|---|---|---|---|---|
| 20C30138 (continued) | Nipple (QD) (umbilical, lox 2-aft) | RA1775 17 Nov 67 | RA3031 17 Nov 67 | 2.2.25.5 |
| | (umbilical, lox 4-aft) | RA1768 17 Nov 67 | RA3023 17 Nov 67 | 2.2.25.5 |
| 20C30141 | Nipple (QD) (umbilical, lox 4-aft) | 0007 23 Oct 67 | RA2495 23 Oct 67 | 2.2.18 |
| 20C30141 (60C22140 installed) | Nipple (QD) Coupling Half installed (umbilical, lox 4-aft) | RA1101 20 Oct 67 | RA3000 20 Oct 67 | 2.2.22 |
| 20C30165 | 1-Inch Coupling Assembly (umbilical, lox 4-aft) | RA0016 23 Oct 67 | RA2612 23 Oct 67 | 2.2.18 |
| 20C40160 | Thermal Probe (engine 2) | 6-2-1 22 Sep 67 | NSN 22 Sep 67 | 4.2.1.10 |
| | (engine 2) | 6-2-2 22 Sep 67 | NSN 22 Sep 67 | 4.2.1.10 |
| 20C85035 | Main Hydraulic Pump (engine 4) | 93021 7 Sep 67 | 93082 7 Sep 67 | 2.2.18 |

Table 5-1. Component Replacement Record (continued)

| Part Number | Name | Serial Number & Date Removed | Serial Number & Date Installed | Paragraph Reference |
|---|---|---|---|---|
| 30C00430 (30C00595 installed) | Mounting Stud lox 1 (S21-O1) | NSN 8 Sep 66 | 34 8 Sep 66 | 2.2.9 |
| | lox 1 (S22-O1) | NSN 9 Sep 66 | 077 9 Sep 66 | 2.2.9 |
| | lox 2 (S21-O2) | NSN 9 Sep 66 | 43 9 Sep 66 | 2.2.9 |
| | lox 2 (S22-O2) | NSN 9 Sep 66 | 078 9 Sep 66 | 2.2.9 |
| | lox 3 (S21-O3) | NSN 9 Sep 66 | 073 9 Sep 66 | 2.2.9 |
| | lox 3 (S22-O3) | NSN 9 Sep 66 | 079 9 Sep 66 | 2.2.9 |
| | lox 4 (S21-O4) | NSN 9 Sep 66 | 074 9 Sep 66 | 2.2.9 |
| | lox 4 (S22-O4) | NSN 9 Sep 66 | 080 9 Sep 66 | 2.2.9 |
| 40C39515-105 (40C39515-119 installed) | EBW Firing Unit number 2 for retro rocket 1 (11A25) | 158 1 Sep 67 | 485 1 Sep 67 | 2.2.17.1 |

Table 5-1. Component Replacement Record (continued)

| Part Number | Name | Serial Number & Date Removed | Serial Number & Date Installed | Paragraph Reference |
|---|---|---|---|---|
| 40C39515-105 (40C39515-119 installed) (continued) | EBW Firing Unit number 1 for retro rocket 2 (11A26) | 159 1 Sep 67 | 484 1 Sep 67 | 2.2.17.1 |
| | number 2 for retro rocket 2 (11A27) | 161 1 Sep 67 | 479 1 Sep 67 | 2.2.17.1 |
| | number 1 for retro rocket 3 (11A28) | 160 1 Sep 67 | 483 1 Sep 67 | 2.2.17.1 |
| | number 2 for retro rocket 3 (11A29) | 163 1 Sep 67 | 482 1 Sep 67 | 2.2.17.1 |
| | number 1 for retro rocket 4 (11A30) | 157 1 Sep 67 | 480 1 Sep 67 | 2.2.17.1 |
| | number 2 for retro rocket 4 (11A31) | 146 1 Sep 67 | 476 1 Sep 67 | 2.2.17.1 |
| | number 1 for retro rocket 1 (11A44) | 162 1 Sep 67 | 481 1 Sep 67 | 2.2.17.1 |

Table 5-1. Component Replacement Record (continued)

| Part Number | Name | Serial Number & Date Removed | Serial Number & Date Installed | Paragraph Reference |
|---|---|---|---|---|
| 40C39515-111 (40C39515-123 installed) | EBW Firing Unit number 1, propellant dispersion (11A42) | 430 7 Dec 67 | 531 7 Dec 67 | 2.2.17.2 |
| | number 2, propellant dispersion (11A43) | 429 7 Dec 67 | 495 7 Dec 67 | 2.2.17.2 |
| 50C10100-1 | Temperature Gauge (C600-7) | 0009 9 Feb 68 | RA2361 9 Feb 68 | 4.3.3.1 |
| 50C10259 | Pressure Transducer (D600-8) | M2096 16 Jan 68 | M2092 22 Jan 68 | 4.3.3.5.1 |
| | Pressure Transducer (D600-8) | M2092 31 Jan 68 | M2354 13 Feb 68 | 4.3.3.5.2 |
| 50C10306 | Pressure Transducer (D122-3) | 8-2165 24 Jan 68 | 4-6611 26 Jan 68 | 4.3.3.4 |
| 50C10377 | Calibration Valve (D14-6) | 2662 2 Dec 66 | 1307 19 Dec 66 | 2.2.14 |
| 50C10394-149 (50C10394-79 installed) | DC Amplifier C631-7 (C600-7 installed) | 1345 27 Sep 66 | 2162 27 Sep 66 | 4.3.3.1 |

Table 5-1. Component Replacement Record (continued)

| Part Number | Name | Serial Number & Date Removed | Serial Number & Date Installed | Paragraph Reference |
|---|---|---|---|---|
| 50C10396 | Pressure Transducer (D119-9) | 4-4778 20 Dec 67 | 4-1910 20 Dec 67 | 4.2.3.5 |
| 50C10397 | Pressure Transducer (D14-4) | 6-6285 12 Jan 68 | 4-1922 16 Jan 68 | 4.3.3.2 |
| 50M10698 | Range Safety Decoder (13A500) | 0038 16 Jan 68 | 0198 16 Jan 68 | 4.3.3.11 |
| 50C12181 | ODOP Transponder (13A498) | 29 6 Dec 66 | 31 6 Dec 66 | 2.2.6 |
| 50C12187-1 | PCM/RF Assembly P1 (13A486) | 009 5 Jan 68 | 001 18 Jan 68 | 4.3.3.10 |
| 50C12325 | Pressure Transducer (D34-1) | 6-9268 17 Jan 68 | 6-9272 25 Jan 68 | 4.3.3.3 |
| | Pressure Transducer (D34-8) | 7-7954 17 Jan 68 | 29-668 25 Jan 68 | 4.3.3.3 |
| | Pressure Transducer (XD35-5) | 7-7957 17 Jan 68 | 6-6166B 25 Jan 68 | 4.3.3.7 |
| 50C66811 | Measurement Calibrator (9A516) | 243 8 Jan 68 | 296 8 Jan 68 | 4.3.3.8 |

Table 5-1. Component Replacement Record (continued)

| Part Number | Name | Serial Number & Date Removed | Serial Number & Date Installed | Paragraph Reference |
|---|---|---|---|---|
| 60C00423 | Push Switch (vent valve, fuel 3) | 003 21 Nov 66 | 008 21 Nov 66 | 2.2.13 |
| | (vent valve, fuel 4) | 002 21 Nov 66 | 009 21 Nov 66 | 2.2.13 |
| 60C20003 (60C21690 installed) | Fuel Depletion Sensor (fuel 2) | 570021 5 Sep 67 | 570021 4 Oct 67 | 2.2.20 |
| | (fuel 4) | 570009 5 Sep 67 | 570009 5 Oct 67 | 2.2.20 |
| 60C20452 | $GN_2$ Control High Pressure Switch | 25266 7 Sep 67 | 25274 5 Oct 67 | 4.2.2.10 |
| 60C20739 | Auxiliary Pump Motor (engine 1) | 1352867 6 Apr 67 | 1297575 31 Aug 67 | 4.2.2.12 |
| | (engine 2) | 1352864 6 Apr 67 | 1297573 31 Aug 67 | 4.2.2.12 |
| | (engine 3) | 1352863 5 Apr 67 | 1297833 31 Aug 67 | 4.2.2.12 |
| 60C20847 | Auxiliary Pump Motor (engine 4) | 101 6 Apr 67 | 105 8 Jun 67 | 4.2.2.12 |

Table 5-1. Component Replacement Record (continued)

| Part Number | Name | Serial Number & Date Removed | Serial Number & Date Installed | Paragraph Reference |
|---|---|---|---|---|
| 60C20894-1 | Water Quench Valve (position I) | 911 20 Oct 67 | 1177 24 Oct 67 | 2.2.23 |
| | (position II) | 1002 25 Oct 67 | 1378 25 Oct 67 | 2.2.23 |
| | (position III) | 998 25 Oct 67 | 1376 25 Oct 67 | 2.2.23 |
| | (position IV) | 912 22 Sep 67 | 1379 26 Oct 67 | 2.2.23 |
| 60C21230 | Gox Vent Line Extension (lox 3) | C32915 5 Sep 67 | 037-030 23 Oct 67 | 2.2.25.3 4.2.2.5 |
| | (lox 4) | C32913 5 Sep 67 | 096-025 23 Oct 67 | 2.2.25.3 4.2.2.5 |
| 60C21263-1 | Gox Venting Assembly (lox 3) | C0001 5 Sep 67 | 1382 23 Oct 67 | 2.2.25.3 4.2.2.5 |
| | (lox 4) | C0004 5 Sep 67 | 1250 23 Oct 67 | 2.2.25.3 4.2.2.5 |

Table 5-1. Component Replacement Table (continued)

| Part Number | Name | Serial Number & Date Removed | Serial Number & Date Installed | Paragraph Reference |
|---|---|---|---|---|
| 60C21404-1 | Lox Vent and Relief Valve (lox 3) | 891 7 Dec 67 | 770 7 Dec 67 | 2.2.25.2 |
| 60C21490-1 | Fuel Safety Relief Valve (fuel 3) | 14 1 Sep 67 | 0014 19 Oct 67 | 2.2.26 |
| 60C26025-1 | Lox Fill and Drain Valve (lox 3) | 101 26 Sep 66 | 102 26 Oct 66 | 2.2.8.2 |
| 60C26025-3 | Fuel Fill and Drain Valve (fuel 1) | 101 26 Sep 66 | 112 26 Oct 66 | 2.2.8.2 |
| | (fuel 1) | 112 31 Jan 68 | 102 31 Jan 68 | 4.3.2.3 |
| 60C40519 | Cable Assembly (9W106) | NSN 15 Mar 68 | NSN 15 Mar 68 | 4.2.1.6 |
| 60C50205 (50C10100-1 installed ) | Temperature Gauge C631-7 (C600-7 installed) | NSN 23 Sep 66 | 0009 23 Sep 66 | 4.3.3.1 |

Table 5-1. Component Replacement Record (continued)

| Part Number | Name | Serial Number & Date Removed | Serial Number & Date Installed | Paragraph Reference |
|---|---|---|---|---|
| 60C50206 (50C10402-1 installed) | Zone Box C631-7 (C600-7 installed) | 101 27 Oct 66 | 251 27 Oct 66 | 4.3.3.1 |
| NA5-27187-2B | FABU Heater Blanket (engine 4) | 155 4 Jan 67 | 152 4 Jan 67 | 4.2.1.11 |
| NA5-27189T1-1A | Hypergol Igniter Monitor Switch (engine 3) | 106 29 Jan 68 | NSN 29 Jan 68 | 4.3.1.2 |
| NA5-27189T1-1B | Hypergol Igniter Monitor Switch (engine 5) | NSN 29 Jan 68 | NSN 29 Jan 68 | 4.3.1.2 |
| NA5-27446 (NA5-27456 installed) | TOP Switch (forward, engine 2) | 25357 28 Nov 67 | 25985A 28 Nov 67 | 4.2.1.13 |
| | (forward, engine 3) | 25354 28 Nov 67 | 25923A 28 Nov 67 | 4.2.1.13 |
| | (forward, engine 4) | 25513 28 Nov 67 | 25986A 28 Nov 67 | 4.2.1.13 |
| NA5-27446 (NA5-27445 installed) | TOP Switch (forward, engine 6) | 25503 3 Oct 67 | 25792A 3 Oct 67 | 4.2.1.12 |

Table 5-1. Component Replacement Record (continued)

| Part Number | Name | Serial Number & Date Removed | Serial Number & Date Installed | Paragraph Reference |
|---|---|---|---|---|
| 502235-21 | Cable Assembly (1W5) | NSN 3 Nov 67 | NSN 3 Nov 67 | 4.2.1.2 |

## 5.1.2 LIMITED-LIFE COMPONENT DATA

Limited-life components are parts and assemblies that deteriorate or otherwise change their characteristics through use (operating time or cycles/firings) or through the passing of time (age control). Most serialized components have a definitely established life limit that, when reached, must be replaced and/or refurbished. The specified replacement time is determined by reliability studies and evaluation of previous component failures. The time of replacement is established at a point where component reliability factors are high and probability-of-failure factors are near zero. Components not replaced at this time enter into a phase where reliability diminishes and probability of failure greatly increases.

5.1.2.1 Operating Time. Records are maintained on the operating time or number of cycles/firings on certain critical components as defined by the CCSD Engineering Department in compliance with WAN 108 and WAN 108A. Table 5-2 identifies these components and provides the total known accumulated operating time or number of cycles/firings. It should be noted that vendors are not obligated to furnish operating time to CCSD; therefore, this table may not contain operating time/cycles accumulated by the vendor. Component replacement is required when the accumulated time or cycles/firings reaches the amount shown in the right-hand column of table 5-2, or whenever it becomes known that the life will expire prior to mission completion. Table 5-2 is a replacement for table 1-6 of the basic publication.

Table 5-2. Total Operating Time and Cycles of Limited-Life Components

| Part Number | Serial Number | Component Name | Total Time thru 19 March 1968 | Life Limit |
|---|---|---|---|---|
| 20C85064 | MX111547 | Pump, Auxiliary Hydraulic (engine 1) | 11 hrs - 7 mins | 50 hours |
| | MX111553 | (engine 2) | 8 hrs - 6 mins | 50 hours |
| | MX111558 | (engine 3) | 7 hrs - 46 mins | 50 hours |
| 40C20002 | 14746 | Master Measuring Voltage Supply (9A85) | 1493 hrs - 51 mins | see note 1 |
| | 18821 | (12A38) | 1493 hrs - 51 mins | see note 1 |
| | 18829 | (9A84) | 1493 hrs - 51 mins | see note 1 |
| 40C39515-107 | 330 | Explosive Bridge Wire Firing Unit Number 2 for separation (11A14) | 40 hrs - 59 mins<br>41 firings<br>(see note 6) | 1000 firings |
| | 349 | Number 1 for separation (11A13) | 36 hrs - 59 mins<br>41 firings<br>(see note 6) | 1000 firings |

Table 5-2. Total Operating Time and Cycles of Limited-Life Components (continued)

| Part Number | Serial Number | Component Name | Total Time thru 19 March 1968 | Life Limit |
|---|---|---|---|---|
| 40C39515-119 | 476 | Explosive Bridge Wire Firing Unit Number 2 for retro rocket 4 (11A31) | 77 firings | 1000 firings |
| | 479 | Number 2 for retro rocket 2 (11A27) | 66 firings | 1000 firings |
| | 480 | Number 1 for retro rocket 4 (11A30) | 86 firings | 1000 firings |
| | 481 | Number 1 for retro rocket 1 (11A44) | 81 firings | 1000 firings |
| | 482 | Number 2 for retro rocket 3 (11A29) | 65 firings | 1000 firings |
| | 483 | Number 1 for retro rocket 3 (11A28) | 72 firings | 1000 firings |
| | 484 | Number 1 for retro rocket 2 (11A26) | 74 firings | 1000 firings |

Table 5-2. Total Operating Time and Cycles of Limited-Life Components (continued)

| Part Number | Serial Number | Component Name | Total Time thru 19 March 1968 | Life Limit |
|---|---|---|---|---|
| 40C39515-119 (continued) | 485 | Explosive Bridge Wire Firing Unit Number 2 for retro rocket 1 (11A25) | 75 firings | 1000 firings |
| 40C39515-123 | 495 | Explosive Bridge Wire Firing Unit Number 2, Propellant Dispersion (11A43) | 79 firings | 1000 firings |
| | 531 | Number 1, Propellant Dispersion (11A42) | 63 firings | 1000 firings |
| 50M10697 | 23 | Secure Command Receiver Number 1 (13A499) | 116 hrs - 39 mins | see note 1 |
| | 75 | Number 2 (13A501) | 40 hrs - 52 mins | see note 1 |
| 50M10698 | 0049 | Range Safety Decoder Number 2 (13A502) | 142 hrs - 11 mins | see note 1 |

Table 5-2. Total Operating Time and Cycles of Limited-Life Components (continued)

| Part Number | Serial Number | Component Name | Total Time thru 19 March 1968 | Life Limit |
|---|---|---|---|---|
| 50M10698 (continued) | 0198 | Range Safety Decoder Number 1 (13A500) | 22 hrs - 52 mins | see note 1 |
| 50C12088-3 | 008 | Remote Digital Submultiplexer (9A700) | 401 hrs - 4 mins | see note 3 |
| 50C12181 | 31 | ODOP Transponder (13A498) | 27 hrs - 49 mins | see note 1 |
| 50C12187-1 | 001 | PCM/RF Assembly P1 (13A486) | 42 hrs - 12 mins | see note 4 |
| 50C12196-7 | 005 | RF Container Assembly F1 (13A451) | 168 hrs - 15 mins | see note 4 |
| 50C67864-5 | 115 | Switch Selector (12A42) | 1097 hrs - 38 mins<br>127,731 cycles (see note 5) | see note 1<br>250,000 cycles |

Table 5-2. Total Operating Time and Cycles of Limited-Life Components (continued)

| Part Number | Serial Number | Component Name | Total Time thru 19 March 1968 | Life Limit |
|---|---|---|---|---|
| 60C20058 | 25259 | Switch, Lox Emergency Vent (11A54) | 58 cycles | see note 2 |
| 60C20339 | 143 | Valve Assembly, Ball Rotor Shutoff, Lox (prevalve, engine 4) | 577 cycles | see note 2 |
| | 147 | (prevalve, engine 3) | 577 cycles | see note 2 |
| | 148 | (prevalve, engine 8) | 563 cycles | see note 2 |
| | 149 | (prevalve, engine 7) | 576 cycles | see note 2 |
| | 150 | (prevalve, engine 6) | 577 cycles | see note 2 |
| | 151 | (prevalve, engine 2) | 572 cycles | see note 2 |
| | 153 | (prevalve, engine 1) | 575 cycles | see note 2 |
| | 167 | (prevalve, engine 5) | 177 cycles | see note 2 |
| 60C20340 | 134 | Valve Assembly, Ball Rotor Shutoff, Fuel (prevalve, engine 8) | 566 cycles | see note 2 |

Table 5-2. Total Operating Time and Cycles of Limited-Life Components (continued)

| Part Number | Serial Number | Component Name | Total Time thru 19 March 1968 | Life Limit |
|---|---|---|---|---|
| 60C20340 (continued) | 144 | Valve Assembly, Ball Rotor Shutoff, Fuel (prevalve, engine 4) | 576 cycles | see note 2 |
| | 146 | (prevalve, engine 5) | 583 cycles | see note 2 |
| | 147 | (prevalve, engine 1) | 568 cycles | see note 2 |
| | 148 | (prevalve, engine 2) | 567 cycles | see note 2 |
| | 150 | (prevalve, engine 6) | 565 cycles | see note 2 |
| | 154 | (prevalve, engine 3) | 558 cycles | see note 2 |
| | 156 | (prevalve, engine 7) | 564 cycles | see note 2 |
| 60C20715 | 100484 | Pump, Auxiliary Hydraulic (engine 4) | 3 hrs - 35 mins | 50 hours |
| 60C20739 | 1297573 | Motor, Auxiliary Hydraulic Pump (engine 2) | 9 hrs - 4 mins<br>184 starts | 50 hours<br>250 starts |
| | 1297575 | (engine 1) | 3 hrs - 47 mins<br>79 starts | 50 hours<br>250 starts |

Table 5-2. Total Operating Time and Cycles of Limited-Life Components (continued)

| Part Number | Serial Number | Component Name | Total Time thru 19 March 1968 | Life Limit |
|---|---|---|---|---|
| 60C20739 (continued) | 1297833 | Motor, Auxiliary Hydraulic Pump (engine 3) | 8 hrs - 44 mins<br>190 starts | 50 hours<br>250 starts |
| 60C20790 | 120 | Valve, Fuel Pressurizing (number 1) | 656 cycles | see note 2 |
| | 126 | (number 2) | 317 cycles | see note 2 |
| 60C20847 | 105 | Motor, Auxiliary Hydraulic Pump (engine 4) | 2 hrs - 39 mins<br>69 starts | 50 hours<br>250 starts |
| 60C20890-3 | 25266 | Switch, Lox Pressurization | 97 cycles | see note 2 |
| 60C21404-1 | 770 | Valve Assembly, Lox Relief (11A54) | 568 cycles | see note 2 |

Table 5-2. Total Operating Time and Cycles of Limited-Life Components (continued)

| Part Number | Serial Number | Component Name | Total Time thru 19 March 1968 | Life Limit |
|---|---|---|---|---|
| 60C21490-1 | 0014 | Valve Assembly, Fuel Vent (fuel 3) | 423 cycles | see note 2 |
| | 11 | (fuel 4) | 828 cycles | see note 2 |
| 60C50079-3 | 001 | PCM/DDAS Assembly P1 (13A485) | 2565 hrs - 8 mins | see note 3 |
| 60C50081-19 | 009 | TM Multiplexer P1A (13A440) | 1558 hrs - 40 mins | see note 3 |
| 60C50081-21 | 010 | TM Multiplexer P1B (13A484) | 1560 hrs - 31 mins | see note 3 |
| 60C50142-1 | 001 | TM Assembly F1 (13A450) | 1252 hrs - 27 mins | see note 3 |
| NA5-27445 | 25792A | Thrust OK Pressure Switch (forward position, engine 6) | 41 cycles | see note 2 |

Table 5-2. Total Operating Time and Cycles of Limited-Life Components (continued)

| Part Number | Serial Number | Component Name | Total Time thru 19 March 1968 | Life Limit |
|---|---|---|---|---|
| NA5-27446 | 25313 | Thrust OK Pressure Switch (inboard position, engine 3) | 164 cycles | see note 2 |
| | 25358 | (forward position, engine 1) | 160 cycles | see note 2 |
| | 25359 | (outboard position, engine 3) | 164 cycles | see note 2 |
| | 25363 | (outboard position, engine 2) | 152 cycles | see note 2 |
| | 25366A | (outboard position, engine 1) | 160 cycles | see note 2 |
| | 25402 | (inboard position, engine 1) | 160 cycles | see note 2 |
| | 25442 | (outboard position, engine 5) | 160 cycles | see note 2 |
| | 25456 | (forward position, engine 7) | 162 cycles | see note 2 |
| | 25502 | (outboard position, engine 7) | 162 cycles | see note 2 |

Table 5-2. Total Operating Time and Cycles of Limited-Life Components (continued)

| Part Number | Serial Number | Component Name | Total Time thru 19 March 1968 | Life Limit |
|---|---|---|---|---|
| NA5-27446 (continued) | 25505 | Thrust OK Pressure Switch (inboard position, engine 5) | 167 cycles | see note 2 |
| | 25506 | (outboard position, engine 8) | 163 cycles | see note 2 |
| | 25507 | (inboard position, engine 7) | 164 cycles | see note 2 |
| | 25508 | (outboard position, engine 4) | 163 cycles | see note 2 |
| | 25510 | (inboard position, engine 8) | 171 cycles | see note 2 |
| | 25511 | (forward position, engine 5) | 161 cycles | see note 2 |
| | 25512 | (outboard position, engine 6) | 166 cycles | see note 2 |
| | 25514 | (inboard position, engine 6) | 167 cycles | see note 2 |
| | 25515 | (inboard position, engine 4) | 161 cycles | see note 2 |

Table 5-2. Total Operating Time and Cycles of Limited-Life Components (continued)

| Part Number | Serial Number | Component Name | Total Time thru 19 March 1968 | Life Limit |
|---|---|---|---|---|
| NA5-27446 (continued) | 25516 | Thrust OK Pressure Switch (forward position, engine 8) | 168 cycles | see note 2 |
| | 25548 | (inboard position, engine 2) | 67 cycles | see note 2 |
| NA5-27456 | 25923 | (forward position, engine 3) | 23 cycles | see note 2 |
| | 25985 | (forward position, engine 2) | 19 cycles | see note 2 |
| | 25986 | (forward position, engine 4) | 23 cycles | see note 2 |

NOTES:

1. Constitutes total time accumulated. Maximum allowable life has not been established.

2. Constitutes total cycles accumulated. Maximum allowable life has not been established.

3. The cognizant design engineering section shall be notified when 3000 hours of operating time have been accumulated on this unit; however, 3000 hours shall not be considered the maximum service life.

Table 5-2. Total Operating Time and Cycles of Limited-Life Components (continued)

| Part Number | Serial Number | Component Name | Total Time thru 19 March 1968 | Life Limit |
|---|---|---|---|---|

4. The cognizant design engineering section shall be notified when 500 hours of operating time have been accumulated and again when 1500 hours have been accumulated; however, 500 hours or 1500 hours shall not be considered the maximum service life.

5. A change was made against the switch selector which required that operating time be kept by amount of cycles as well as time (hrs/mins). This change was not implemented into MAF or MSFC operations until after post storage checkout of S-IB-5 stage; therefore, the cycles appearing in this report for the switch selector is an estimation of cycles accumulated during the checkouts of S-IB-5 stage. This estimation was furnished by the CCSD Quality Control Engineering Section.

6. A change was made against the EBW firing units which requires that operating time be kept by amount of firings rather than time (hrs/min). This change was not implemented into MAF operations until after post-static checkout of S-IB-5 stage; therefore a portion of the accumulated operating time is by firings and a portion by hrs/mins.

5.1.2.2 Age Control. The synthetic rubber O-rings or other synthetic rubber parts of components and assemblies in the S-IB stage change their characteristics with the passage of time. A complete record of age of the components must be maintained to assure that the installed life of the component is not exceeded.

5.1.2.2.1 Age Control records for stage S-IB-5 were maintained in accordance with MSFC-Standard-105A and Amendment 2. Amendment 2 to MSFC-Standard-105A extends the installed life of all synthetic rubber to 24 quarters (6 years).

5.1.2.2.2 Table 5-3 identifies the limited-life components on stage S-IB-5 that contain age-controlled synthetic rubber goods. The two left-hand columns list the replacement date (R/D) and the assembly date (A/D). The A/D is given by the quarter and year in which the oldest rubber was installed into the component. The R/D is the calendar date at which replacement of the rubber in the component is required, and is the last date in the quarter for the useful life of the rubber. All entries in table 5-3 are in order by replacement date, then by part number and serial number. The last column of table 5-3 lists the specifications or drawings to which the components were procured or manufactured. Table 5-3 is a replacement for table 1-7 of the basic publication.

5.1.2.2.3 It should be noted that the age-control identification stickers on the components were not changed to reflect the 24-quarter installed life as specified on Amendment 2 to MSFC-Standard-105A which was released 7 September 1967. Only the associated stage documentation was altered to reflect this change. The component appearing in table 5-3, having double asterisks (**), was installed on S-IB-5 stage after Amendment 2 to MSFC-Standard-105A was released and does, in fact, reflect the 24-quarter installed life on the sticker.

Table 5-3. Age Control Data, Limited-Life Components

| R/D | A/D | Part Number | Serial Number | Component Name | Component Specification |
|---|---|---|---|---|---|
| 30 Sep 70 | 3Q64 | 20C30165 | RA0032<br>RA0034<br>RA0035 | Coupling Assembly, 1-Inch (lox 2-aft, umbilical) | 10C01377 |
| | | 20C30391 | RA0311 | Nipple, Quick Disconnect (lox 2-aft, umbilical) | 10C01377 |
| | | | RA0312 | (lox 2-forward, umbilical) | 10C01377 |
| | | 20C85035 | 93042 | Pump, Main Hydraulic (engine 3) | 20C85035 |
| 31 Dec 70 | 4Q64 | 20C00878 | 0004 | Manifold Assembly, $GN_2$ Control Pressure | 20C00878 |
| | | 60C60001 | 311 | Servo Actuator (lox side, engine 1) | 10C01683 |
| 31 Mar 71 | 1Q65 | 20C00448 | 102 | Swivel Joint (lox 2) | 20C00448 |
| | | | 103 | (lox 4) | 20C00448 |
| | | | 104 | (lox 2) | 20C00448 |

Table 5-3. Age Control Data, Limited-Life Components (continued)

| R/D | A/D | Part Number | Serial Number | Component Name | Component Specification |
|---|---|---|---|---|---|
| 31 Mar 71 (continued) | 1Q65 | 20C00448 | 105 | Swivel Joint (lox 2) | 20C00448 |
| | | | 106 | (lox 3) | 20C00448 |
| | | | 107 | (lox 1) | 20C00448 |
| | | | 108 | (lox 3) | 20C00448 |
| | | | 109 | (lox 4) | 20C00448 |
| | | | 110 | (lox 1) | 20C00448 |
| | | | 111 | (lox 4) | 20C00448 |
| | | | 112 | (lox 3) | 20C00448 |
| | | | 113 | (lox 1) | 20C00448 |
| | | 20C30146 | RA0710 | Dust Cap, Quick Disconnect (lox 4-aft, umbilical) | 20C30146 |
| | | 20C30147 | RA0714 | Dust Cap, Quick Disconnect (lox 2-forward, umbilical) | 20C30147 |
| | | 20C30148 | RA0669 | Dust Cap, Quick Disconnect (lox 2-aft, umbilical) | 20C30148 |
| | | 20C30149 | RA0672 RA0685 | Dust Cap, Quick Disconnect (lox 4-aft, umbilical) | 20C30149 |

Table 5-3. Age Control Data, Limited-Life Components (continued)

| R/D | A/D | Part Number | Serial Number | Component Name | Component Specification |
|---|---|---|---|---|---|
| 31 Mar 71 (continued) | 1Q65 | 20C30160 | 515 | Valve, Calorimeter Purge | 10C01146 |
| | | 20C30167 | RA0701<br>RA0703<br>RA0706 | Dust Cap, Quick Disconnect (lox 2-aft, umbilical) | 20C30167 |
| | | 20C30168 | RA0690 | Dust Cap, Quick Disconnect (lox 2-aft, umbilical) | 20C30168 |
| | | 20C30178 | RA0695 | Dust Cap, Quick Disconnect (lox 4-aft, umbilical) | 20C30178 |
| | | 20C30389 | RA0653 | Nipple, Quick Disconnect (lox 4-aft, umbilical) | 10C01377 |
| | | 20C30390 | RA0492<br>RA0493 | Nipple, Quick Disconnect (lox 4-aft, umbilical) | 10C01377 |
| | | 20C85064 | MX111547 | Auxiliary Hydraulic Pump (engine 1) | 20C85064 |
| | | | MX111553 | (engine 2) | 20C85064 |

Table 5-3. Age Control Data, Limited-Life Components (continued)

| R/D | A/D | Part Number | Serial Number | Component Name | Component Specification |
|---|---|---|---|---|---|
| 31 Mar 71 (continued) | 1Q65 | 20C85064 | MX111558 | Auxiliary Hydraulic Pump (engine 3) | 20C85064 |
| | | 60C20748-1 | 147 | Hydraulic Package Assembly (engine 1) | 20C85076 |
| | | | 148 | (engine 2) | 20C85076 |
| | | | 151 | (engine 3) | 20C85076 |
| | | 60C20790 | 120 | Valve Assembly, Fuel Pressurizing (number 1) | 60C26002 |
| | | | 126 | (number 2) | 60C26002 |
| | | 60C60001 | 336 | Servo Actuator (fuel side, engine 2) | 10C01683 |
| 30 Jun 71 | 2Q65 | 20C30128 | 905 | Valve Assembly, Solenoid Operated (prevalve control, engine 2) | 10C01374 |
| | | | 906 | (prevalve control, engine 3) | 10C01374 |
| | | | 908 | (prevalve control, engine 5) | 10C01374 |

Table 5-3. Age Control Data, Limited-Life Components (continued)

| R/D | A/D | Part Number | Serial Number | Component Name | Component Specification |
|---|---|---|---|---|---|
| 30 Jun 71 (continued) | 2Q65 | 20C30128 | 913 | Valve Assembly, Solenoid Operated (prevalve control, engine 7) | 10C01374 |
| | | | 914 | (prevalve control, engine 8) | 10C01374 |
| | | | 916 | (prevalve control, engine 6) | 10C01374 |
| | | | 917 | (prevalve control, engine 4) | 10C01374 |
| | | | 918 | (prevalve control, engine 1) | 10C01374 |
| | | 20C30137 | CH021 | Relief Valve, $GN_2$ Control Pressure | 10C01148 |
| | | 20C30139 | RA0670 | Nipple, Quick Disconnect (lox 2-aft, umbilical) | 10C01377 |
| | | | RA0806 RA0807 | (lox 2-forward umbilical) | 10C01377 |
| | | 20C30166 | 0003 | Coupling Assembly, 1.25 Inch (lox 2-aft, umbilical) | 10C01377 |

Table 5-3. Age Control Data, Limited-Life Components (continued)

| R/D | A/D | Part Number | Serial Number | Component Name | Component Specification |
|---|---|---|---|---|---|
| 30 Jun 71 (continued) | 2Q65 | 20C40000 | 54, 58 | Check Valve, Precool | 10C01379 |
| | | 20C85077 | 183 | Relief Valve, Hydraulic Low-Pressure (engine 1) | 20C85077 |
| | | 20C85078 | 189 | Relief Valve, Hydraulic High-Pressure (engine 3) | 20C85078 |
| | | | 195 | (engine 2) | 20C85078 |
| | | | 196 | (engine 1) | 20C85078 |
| | | 20C85081 | 147 | Nipple, Hydraulic Low-Pressure (engine 1) | 20C85081 |
| | | | 148 | (engine 2) | 20C85081 |
| | | | 151 | (engine 3) | 20C85081 |
| | | 20C85082 | 147 | Nipple, Hydraulic High-Pressure (engine 1) | 20C85082 |
| | | | 148 | (engine 2) | 20C85082 |
| | | | 151 | (engine 3) | 20C85082 |

Table 5-3. Age Control Data, Limited-Life Components (continued)

| R/D | A/D | Part Number | Serial Number | Component Name | Component Specification |
|---|---|---|---|---|---|
| 30 Jun 71 (continued) | 2Q65 | *60C10263-3 | *A55090 | Resilient Mount (quantity 4) | 60C10263 |
| | | | *A56907 | (quantity 10) | 60C10263 |
| | | | *A67254 | (quantity 22) | 60C10263 |
| | | 60C20339 | 143 | Valve Assembly, Ball-Rotor Shutoff, Lox (prevalve, engine 4) | 10C01694 |
| | | | 151 | (prevalve, engine 2) | 10C01694 |
| | | | 153 | (prevalve, engine 1) | 10C01694 |
| | | 60C20340 | 134 | Valve Assembly, Ball-Rotor Shutoff, Fuel (prevalve, engine 8) | 10C01694 |
| | | | 144 | (prevalve, engine 4) | 10C01694 |
| | | | 146 | (prevalve, engine 5) | 10C01694 |
| | | | 147 | (prevalve, engine 1) | 10C01694 |
| | | | 148 | (prevalve, engine 2) | 10C01694 |
| | | | 150 | (prevalve, engine 6) | 10C01694 |
| | | 60C60001 | 348 | Servo Actuator (fuel side, engine 1) | 10C01683 |
| | | | 351 | (fuel side, engine 4) | 10C01683 |
| | | | 354 | (lox side, engine 4) | 10C01683 |
| | | | 355 | (lox side, engine 3) | 10C01683 |

Table 5-3. Age Control Data, Limited-Life Components (continued)

| R/D | A/D | Part Number | Serial Number | Component Name | Component Specification |
|---|---|---|---|---|---|
| 30 Sep 71 | 3Q65 | 20C30128 | 931 | Valve Assembly, Solenoid Operated (control valve, 4-inch lox vent 03) | 10C01374 |
| | | 20C30391 | RA1107 | Nipple, Quick Disconnect (lox 2-aft, umbilical) | 10C01377 |
| | | 20C30409 | RA0979 | Nipple, Quick Disconnect (lox 2-aft, umbilical) | 10C01377 |
| | | 20C85035 | 93024 | Pump, Main Hydraulic (engine 1) | 20C85035 |
| | | | 93046 | (engine 2) | 20C85035 |
| | | 20C85062 | 147 | Accumulator Reservoir and Manifold Assembly (engine 1) | 20C85062 |
| | | | 148 | (engine 2) | 20C85062 |
| | | | 151 | (engine 3) | 20C85062 |

Table 5-3. Age Control Data, Limited-Life Components (continued)

| R/D | A/D | Part Number | Serial Number | Component Name | Component Specification |
|---|---|---|---|---|---|
| 30 Sep 71 (continued) | 3Q65 | 20C85077 | 161 | Relief Valve, Hydraulic Low-Pressure (engine 2) | 20C85077 |
| | | | 189 | (engine 3) | 20C85077 |
| | | 60C20339 | 147 | Valve Assembly, Ball Rotor Shutoff, Lox (prevalve, engine 3) | 10C01694 |
| | | | 148 | (prevalve, engine 8) | 10C01694 |
| | | | 149 | (prevalve, engine 7) | 10C01694 |
| | | | 150 | (prevalve, engine 6) | 10C01694 |
| | | 60C20340 | 154 | Valve Assembly, Ball Rotor Shutoff, Fuel (prevalve, engine 3) | 10C01694 |
| | | | 156 | (prevalve, engine 7) | 10C01694 |
| | | 60C60001 | 352 | Servo Actuator (lox side, engine 2) | 10C01683 |
| 31 Dec 71 | 4Q65 | 20C30146 | RA2723 | Dust Cap, Quick Disconnect (lox 4-aft, umbilical) | 20C30146 |

Table 5-3. Age Control Data, Limited-Life Components (continued)

| R/D | A/D | Part Number | Serial Number | Component Name | Component Specification |
|---|---|---|---|---|---|
| 31 Mar 72 | 1Q66 | 20C00447 | RA1513 | Swivel Joint (lox 1 ) | 20C00447 |
| | | | RA1518 | (lox 4 ) | 20C00447 |
| | | | RA1520 | (lox 2 ) | 20C00447 |
| | | | RA1521 | (lox 3 ) | 20C00447 |
| | | 20C30136 | RA1326 | Nipple, Quick Disconnect (lox 2-forward, umbilical) | 10C01377 |
| | | 20C30148 | RA1732 | Dust Cap, Quick Disconnect (lox 2-forward, umbilical) | 20C30148 |
| | | 20C30409 | RA2729 | Dust Cap, Quick Disconnect (lox 2-forward, umbilical) | 20C30409 |
| | | 60C26025-1 | 102 | Valve Assembly, Lox Fill and Drain | 60C26025 |
| | | 60C60001 | 384 | Servo Actuator (fuel side, engine 3) | 10C01683 |

Table 5-3. Age Control Data, Limited-Life Components (continued)

| R/D | A/D | Part Number | Serial Number | Component Name | Component Specification |
|---|---|---|---|---|---|
| 30 Jun 72 | 2Q66 | 20C30122-1 | CH131 | Valve Assembly, 7-Inch Lox Vent (lox 2) | 10C01154 |
| | | 20C30133 | RA1827 | Nipple, Quick Disconnect (lox 2-forward, umbilical) | 10C01377 |
| | | 20C30139 | RA1788 | Nipple, Quick Disconnect (lox 2-forward, umbilical) | 10C01377 |
| | | 20C30149 | RA1724 | Dust Cap, Quick Disconnect (lox 2-aft, umbilical) | 20C30149 |
| | | | RA2727 | (lox 4-aft, umbilical) | 20C30149 |
| | | 20C85035 | 93082 | Pump, Main Hydraulic (engine 4) | 20C85035 |
| | | 20C85062 | 160 | Accumulator Reservoir and Manifold Assembly (engine 4) | 20C85062 |

Table 5-3. Age Control Data, Limited-Life Components (continued)

| R/D | A/D | Part Number | Serial Number | Component Name | Component Specification |
|---|---|---|---|---|---|
| 30 Jun 72 (continued) | 2Q66 | 20C85077 | 185 | Relief Valve, Hydraulic Low-Pressure (engine 4) | 20C85077 |
| | | 20C85078 | 208 | Relief Valve, Hydraulic High-Pressure (engine 4) | 20C85078 |
| | | 20C85081 | 160 | Nipple, Hydraulic Low-Pressure (engine 4) | 20C85081 |
| | | 20C85082 | 160 | Nipple, Hydraulic High-Pressure (engine 4) | 20C85082 |
| | | 60C20339 | 167 | Valve Assembly, Ball Rotor Shutoff, Lox (prevalve, engine 5) | 10C01694 |
| | | 60C20715 | 100484 | Auxiliary Hydraulic Pump (engine 4) | 60C20715 |

Table 5-3. Age Control Data, Limited-Life Components (continued)

| R/D | A/D | Part Number | Serial Number | Component Name | Component Specification |
|---|---|---|---|---|---|
| 30 Jun 72 (continued) | 2Q66 | 60C20791-1 | 160 | Hydraulic Package Assembly (engine 4) | 20C85076 |
| 30 Sep 72 | 3Q66 | 20C30122-1 | CH106 | Valve Assembly, 7-Inch Lox Vent (lox 4) | 10C01154 |
| | | 60C21506 | CH108 | Regulator Assembly, $GN_2$ Control Pressure | 10C01151 |
| 31 Mar 73 | 1Q67 | **20C30122-1 | 863 | Valve Assembly, 7-Inch Lox Vent (lox 3) | 10C01154 |
| | | 20C30131 | 147 | Valve, Sphere Fill and Vent | 10C01149 |
| | | 20C30145 | RA2722 | Dust Cap, Quick Disconnect (lox 4-aft, umbilical) | 20C30145 |

Table 5-3. Age Control Data, Limited-Life Components (continued)

| R/D | A/D | Part Number | Serial Number | Component Name | Component Specification |
|---|---|---|---|---|---|
| 30 Jun 73 | 2Q67 | 20C30136 | RA2420 | Nipple, Quick Disconnect (lox 2-aft, umbilical) | 10C01377 |
| | | 20C30141 | RA2495 | Nipple, Quick Disconnect (lox 4-aft, umbilical) | 10C01377 |
| | | 20C30148 | RA2462 | Dust Cap, Quick Disconnect (lox 2-aft, umbilical) | 20C30148 |
| | | | RA2464<br>RA2474<br>RA2484 | (lox 2-forward, umbilical) | 20C30148 |
| | | 20C30149 | RA2531<br>RA2532 | Dust Cap, Quick Disconnect (lox 4-aft, umbilical) | 20C30149 |
| | | 20C30165 | RA2612 | Coupling Assembly, 1-Inch (lox 4-aft, umbilical) | 10C01377 |
| | | 20C30409 | RA2730 | Dust Cap, Quick Disconnect (lox 2-forward, umbilical) | 20C30409 |

Table 5-3. Age Control Data, Limited-Life Components (continued)

| R/D | A/D | Part Number | Serial Number | Component Name | Component Specification |
|---|---|---|---|---|---|
| 30 Sep 73 | 3Q67 | 20C00447 | 3 | Swivel Joint (lox 4) | 20C00447 |
| | | | 11 | (lox 1) | 20C00447 |
| | | | 20 | (lox 4) | 20C00447 |
| | | | 35 | (lox 3) | 20C00447 |
| | | | 36 | (lox 2) | 20C00447 |
| | | | 157 | (lox 1) | 20C00447 |
| | | | 178 | (lox 2) | 20C00447 |
| | | | 187 | (lox 3) | 20C00447 |
| | | 20C30167 | RA2728 | Dust Cap, Quick Disconnect (lox 4-aft, umbilical) | 20C30167 |
| | | 60C20894-1 | 1378 | Valve Assembly, Water Quench (position 2) | 60C26018 |
| | | | 1379 | (position 4) | 60C26018 |
| | | 60C12169 | RA2830<br>RA2833<br>RA2834<br>RA2835<br>RA2836<br>RA2837<br>RA2838<br>RA2839 | Resilient Mount | 60C12169 |

Table 5-3. Age Control Data, Limited-Life Components (continued)

| R/D | A/D | Part Number | Serial Number | Component Name | Component Specification |
|---|---|---|---|---|---|
| 30 Sep 73 (continued) | 3Q67 | 60C12169 | RA2841<br>RA2842<br>RA2843<br>RA2845 | Resilient Mount | 60C12169 |
| | | 60C21490-1 | 11 | Valve Assembly, Vent (fuel 4) | 60C26008 |
| | | 60C26025-3 | 102 | Valve Assembly, Fuel Fill and Drain | 60C26025 |
| 31 Dec 73 | 4Q67 | 60C20894-1 | 1177 | Valve Assembly, Water Quench (position 1) | 60C26018 |
| | | | 1376 | (position 3) | 60C26018 |
| | | 60C21490-1 | 0014 | Valve Assembly, Vent (fuel 3) | 60C26008 |

Table 5-3. Age Control Data, Limited-Life Components (continued)

| R/D | A/D | Part Number | Serial Number | Component Name | Component Specification |
|---|---|---|---|---|---|

* At the time the resilient mounts were installed on the stage, serialization control was not a requirement. After the requirement was added, it was considered impracticable or unnecessary to remove the resilient mounts for serialization. However, it was agreed that the stage documentation would reflect the Incoming Material Report (IMR) number applicable to the resilient mounts. Therefore, the number appearing in the serial number column is the IMR number.

** See paragraph 5.1.2.2.3

## 5.1.3 ORIFICE SUMMARY

Orifices are installed on the S-IB stage to control specific pneumatic functions such as response of pneumatically actuated valves, flow rates of purges, and parameters of pressurization. Table 5-4 provides orifice data pertaining to orifices that were changed subsequent to storage of S-IB-5 (with asterisks), as well as orifice data omitted from table 1-4 of the basic publication (without asterisks). Table 5-4 is an amendment to table 1-4 of the basic publication.

Table 5-4. Orifice Summary

| Orifice Part Number | Drawing Size (inches) | Actual Size (inches) | Orifice Location |
|---|---|---|---|
| *60C21407-3 | 0.023 to 0.025 | 0.022 | Fuel prevalve 4 control pressure inlet |
| *60C21407-9 | 0.027 to 0.028 | 0.027 | Fill and drain valve, fuel 1 |
| 60C21408-3 | 0.040 to 0.042 | 0.042 | Control valve for shutoff valves (prevalves, engine 3) |
| | | 0.042 | Control valve for shutoff valves (prevalves, engine 4) |
| | | 0.042 | Control valve for shutoff valves (prevalves, engine 5 |
| | | 0.042 | Control valve for shutoff valves (prevalves, engine 6 |
| | | 0.042 | Control valve for shutoff valves (prevalves, engine 7 |
| | | 0.041 | Control valve for shutoff valves (prevalves, engine 8) |
| 60C21684-1 | 0.018 to 0.020 | 0.019 | Purge for calorimeter 60C50164 measurement C603-6 |

Table 5-4. Orifice Summary (continued)

| Orifice Part Number | Drawing Size (inches) | Actual Size (inches) | Orifice Location |
|---|---|---|---|
| F61C1543-5 | 0.098 (±0.002) | 0.099 | Lox shutoff valve control pressure inlet (prevalve, engine 1) |
| | | 0.099 | Lox shutoff valve control pressure inlet (prevalve, engine 2) |
| *F61C-543-5 | 0.098 (±0.002) | 0.099 | Lox shutoff valve control pressure inlet (prevalve, engine 4) |

## 5.1.4 ADDITIONAL OPTICAL TARGETS

An alternate method of establishing basic datum plane -A- (refer to paragraph 3.5 of the basic publication) is being provided in the event that both prick-punch marks are not readily accessible, or that structural twisting during the installation of the prick-punch marks has rendered them inaccurate. The .500/.501-diameter fastener holes (refer to figure 5-1) can be used with an accuracy of ± .005 inch when utilizing the correction factors of tooling hole "X" as shown in table 5-5. Figure 5-1 is a replacement for figure 3-1, section D-D of the basic publication.

Table 5-5. Position of Tooling Hole "X" Relative to Basic Datum Plane -A-

| Fin 1 | Fin 2 | Fin 3 | Fin 4 |
|---|---|---|---|
| +.004 | -.001 | -.030 | -.012 |
| Fin 5 | Fin 6 | Fin 7 | Fin 8 |
| +.012 | +.015 | +.021 | +.006 |

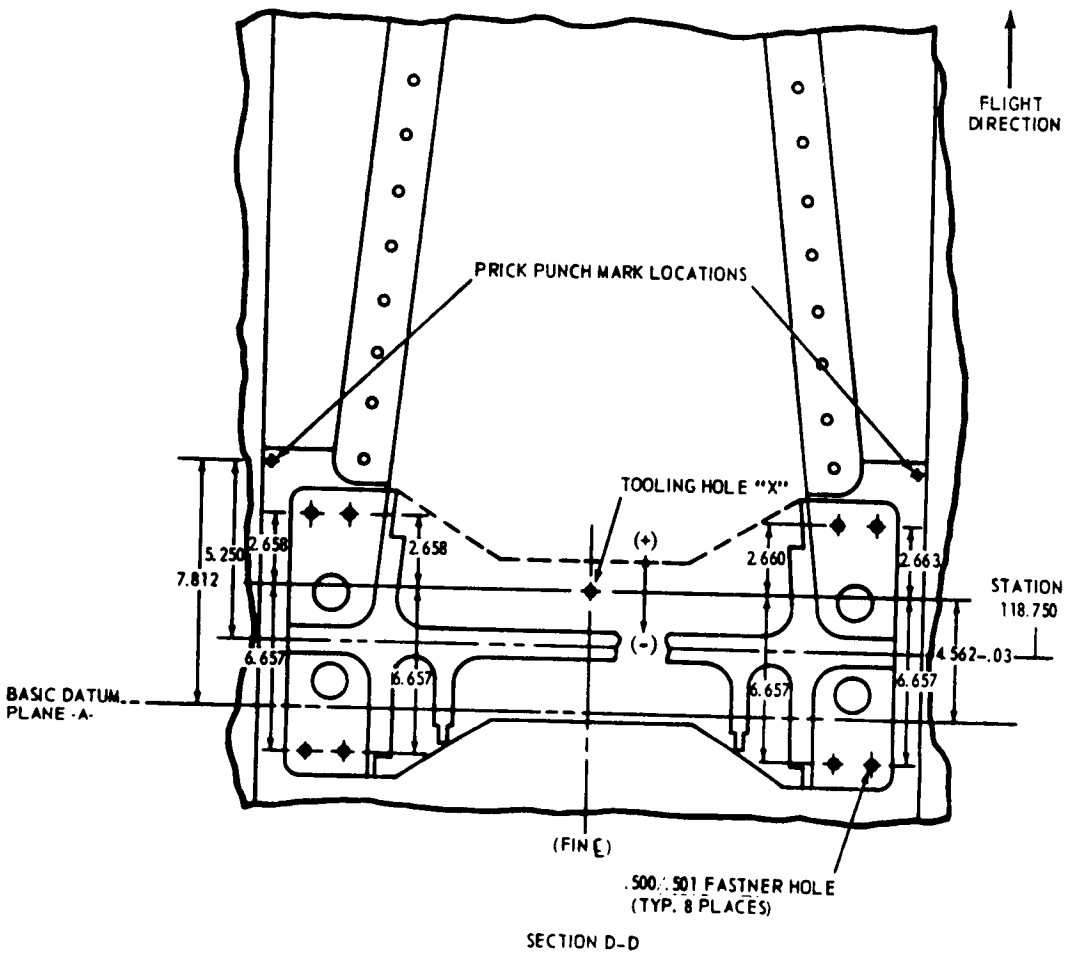


Figure 5-1. Optical Target Alignment Data

## 5.1.5 CRUSH WASHER INSTALLATION

During prestatic, poststatic, and reverification functional checkouts of stage S-IB-5, crush washers were installed at tube assembly fittings in order to stop persistent leakage that could not be stopped by retorqueing, realignment, rework, or replacement of parts. The locations of these crush washers are as follows:

a. Between tube assembly 10C11361-1 and elbow MC200D6 in the $GN_2$ control pressure fill line at the position-IV lower umbilical
Reference: Squawk K25579; item 1

b. Between elbow MC200D6 and coupling 60C20113 on the position-IV lower umbilical
Reference: Squawk K25579; item 1

c. Between tube assembly 60C10940-1 and union MC164D4 at the position-IV lower umbilical, on the end of the tube assembly nearest the firewall
Reference: Squawk K25579; item 5

## 5.1.6 FLEXIBLE DUCTING DAMAGE SUMMARY

Interconnect line 20C00008, serial number 18, (lox-2 container unit assembly to 105-inch container assembly) has one dent 0.020 inch deep, 0.250 inch long, and 0.175 inch wide, located in the bellows nearest the 105-inch lox container assembly sump, on the third convolution from the end nearest the 105-inch lox container assembly. A use-as-is disposition was rendered (reference: DMN M18500). This is an amendment to table 1-3 of the basic publication.

## 5.1.7 ITEMS REQUIRING RETEST AT KSC

Table 5-6 lists the H-1 engine thrust chambers that were repaired, but not fuel leak checked, along with components and assemblies that were repaired, reworked, replaced, or removed and reinstalled after post storage reverification checkout. A

fuel leak check is required on the thrust chambers and pre-launch checkout verification is required on the associated stage systems for all other components and assemblies listed. Table 5-6 is a replacement for table 1-8 of the basic publication. Checkout verification of components appearing in table 1-8 of the basic publication was successfully accomplished during post storage reverification checkout.

Table 5-6. Items Requiring Retest at KSC

| Authorization | Part Number and Serial Number | Part Name |
|---|---|---|
| DMN H00496B | 208959<br>6605326 | Thrust Chamber, Engine 1 |
| DMN H00506A | 208636-21<br>6606696 | Thrust Chamber, Engine 8 |
| DMN H00507A | 208637-11<br>6610272 | Thrust Chamber, Engine 7 |
| DMN M18791 | 20C00524<br>NSN | Tube Assembly, Engine 3 |
| | 60C10565-1<br>NSN | Tube Assembly, Fuel-1 Container Unit Assembly |
| | 60C10640-1<br>NSN | Tube Assembly, Engine 6 |
| | 60C10649-1<br>NSN | Tube Assembly, 105-inch Lox Container-forward |
| | 60C10903-1<br>NSN | Tube Assembly, Engine 3 |
| | 60C11614-1<br>NSN | Tube Assembly, 105-inch Lox Container-aft |

Table 5-6. Items Requiring Retest at KSC (continued)

| Authorization | Part Number and Serial Number | Part Name |
|---|---|---|
| DMN M18792 | 11W32P3<br>11W40P1<br>13W38P1<br>13W40P1<br>13W63P2 | Cable Connector |
| Modification Bulletin WQ-7700/2100 | 50C12088-3<br>008 | RDSM |
| Modification Bulletin WY-7700/2100 | 2W5P2, 2W5P3, 2W5P4, 2W21P4, 2W23P6, and 2W23P8 | Cable Connector |
| Modification Bulletin XA-7700/2100 | 9W1, 9W4, 9W8, 9W9, 9W17, 9W21, 9W23, 9W27, 9W28, 9W29, 9W30, 9W31, 9W35, 9W39, 9W43, 9W49, 9W50, 9W53, 9W56, 9W59, 9W62, 9W95, 9W99, 9W105, 9W106, 9W135, 9W136, 9W144, 9W146, 9W165, 9W210, and 9W211 (all connectors) | Cable Assembly |
| Modification Bulletin XB-7700/2100 | 60C50142-1<br>001 | TM Assembly (13A450) |
| Modification Bulletin XD-7700/2100 | 9W136 | Cable Assembly |
| Modification Bulletin XE-7700/2100 | 50C10099-1<br>RA0834 | Temperature Gauge (C61-1) |

## 5.1.8 FINAL CONFIGURATION DOCUMENTS

In order to determine final configuration of stage S-IB-5, it is necessary to refer to the following list of documents. Special emphasis should be placed on the fact that these documents were shipped with stage S-IB-5 to KSC as part of the stage record book.

5.1.8.1 Engineering Parts List, S-IB-5. The engineering parts list contains all part numbers and engineering orders applicable to stage S-IB-5 and is redlined to define the configuration of the stage at time of shipment to KSC.

5.1.8.2 List of Unincorporated Engineering Orders. This list contains all approved class-I engineering orders that were not fully incorporated into stage S-IB-5 at time of shipment to KSC, and also lists any incorporated engineering orders requiring test or retest at KSC.

5.1.8.3 List of Incompleted/Uncorrected Discrepancies. This list contains all electrical and mechanical items that were reworked, removed, and/or replaced after post storage reverification checkout. Prelaunch checkout verification is required on these components and/or their subsystems.

5.1.8.4 Red-Lined Drawings. Stage electrical schematics, wiring lists, and cable interconnection diagrams shipped with the stage are red-lined to reflect the actual stage configuration showing changes that resulted from the incorporation of engineering orders.

5.1.8.5 Shipped-Loose List. Drawing 60C11885 defines the components that are not installed on stage S-IB-5 when shipped, but are intentionally shipped loose for installation at KSC.

5.1.8.6 MSFC Form 71. The primary shipping document is MSFC Form 71. This form may be consulted for lists of GFP items, shipped-loose items, uncorrected discrepancies, and other similar data.

5.1.8.7 List of Approved Deviations. This list comprises those items on stage S-IB-5 that do not conform to their applicable drawing or specification but are considered acceptable for

use without further change or correction. The list is compiled from DMNs and FFADSs that have been submitted to a NASA/CCSD-staffed Material Review Board where an accept (use as is) or repair disposition was given. A copy of these DMNs and FFADSs is included with the approved deviation list.

# SUPPLEMENT
# ASSEMBLY AND TEST REPORT, S-IB-5

by

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